INSTRUCTION BOOK NO. T500FT

INSTALLATION, OPERATION AND SERVICE

BRISTOL'S SERIES 500 2-CASE TEMPERATURE PROGRAM CONTROLLER WITH ELECTRONIC CONTROLS

SERIAL NO._____ CUST. ORDER NO._____

RECORDING
INDICATING
CONTROLLING
TELEMETERING

INSTRUMENTS

BRISTOL'S

THE BRISTOL COMPANY
WATERBURY 20, CONN.

PLACE THESE INSTRUCTIONS WITH THE MAN IN CHARGE OF YOUR INSTRUMENTS

I M P O R T A N T

1. Read these instructions NOW before installing instrument.

2. Keep these instructions permanently & accessibly filed for future reference.

3. Be sure to specify MODEL & SERIAL numbers when ordering parts, instructions, diagrams or data.

4. Ship instruments or parts for repair or exchange only to Bristol's main or branch factories—not to Sales Offices.

5. Be sure to—
   1. Identify your shipments with your exact return address & order number.
   2. Write nearest Bristol Factory or office giving your order number, directions & address for return shipment, full instructions for repair, etc.

6. Report damage to shipments at once to shipping company. The *customer assumes responsibility for collecting any claim for damages* from the shipping company, on all shipments made on a collect basis.

WHO WILL SERVICE YOUR BRISTOL INSTRUMENT?

Divided responsibility produces misunderstanding and inattention. We therefore urge that all Bristol instruments in your plant be assigned to the care of one responsible man. He will rapidly become so familiar with routine chart changing, inking, checking and adjusting necessary to keep instruments in good working order, as to require only a few minutes time per day. Bristol will be pleased to supply additional information or personal instruction to instrument service men.

INSTRUCTION BOOK NO. T500FT

ISSUE NO. 1

INSTALLATION, OPERATION AND SERVICE

BRISTOL'S SERIES 500 2-CASE TEMPERATURE PROGRAM

CONTROLLER WITH ELECTRONIC CONTROLS

FOR SERIAL NO._____ CUST. ORDER NO._____

INDEX PAGE

THIS BOOK CONTAINS THE FOLLOWING INSTRUCTIONS IN THE FOLLOWING ORDER

ORDER IN BOOK	TITLE	NUMBER
1	Electronic Free-vane Control Instructions	B2030
2	Standard Wiring Diagrams	B2032
3	Thermometer-system Installation	T8000A
4	Parts List for Thermometer Bulb	T8005
5	Time Program Controller Instructions	W18202
6	Parts List for Program Controller	W18203
7	Cam Cutting Instructions	Y19174
8	Instructions for 500 Series Case	Y19800
9	Recording System Instructions	Y19802
10	Thermometer Case Connections and Color Code	Sh 011037
11		
12		
13		
14		
15		
16		
17		
	PLUS FOLLOWING ITEMS AS REQUIRED	
	SPECIAL INSTRUCTIONS	
	WIRING DIAGRAMS	
	Special if required	013008
LAST	ADDRESS & PHONE NUMBERS BRISTOL'S BRANCH FACTORIES & OFFICES	W 18220

Instruction No. B2030
Issued June 1954

INSTRUCTION NO. B2030

(Issue No. 2 of 6/54)

INSTALLATION, OPERATION AND SERVICE OF BRISTOL'S SERIES 500 AND 534 ELECTRONIC FREE-VANE CONTROLLER

TABLE OF CONTENTS

	Page
PART I GENERAL	3
A. Description	3
B. Types of Control	3
C. How the Electronic Control Unit Works	4
D. How the Proportional-input Unit Works	4
PART II INSTALLATION	5
A. Unpacking and Mounting	5
B. Measuring System	5
C. Wiring	5
PART III OPERATION	5
A. How to Start Controllers	5
B. How to Start Controllers with Proportional-input Control	5
C. Checking and Adjusting the Control Point	7
D. Checking and Adjusting the Differential Gap	7
PART IV SERVICE	7
A. Checking the Tubes	7
B. Replacing a Control Unit	7
C. Servicing of Relay Contacts	7
D. How to Install Change Gears on Proportional-input Units	8
E. Repairs, Correspondence and Shipping	8

THE BRISTOL COMPANY WATERBURY 20, CONN.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09350

Instruction No. B2030
Issued June 1954

INSTRUCTION NO. B2030

(Issue No. 2 of 6/54)

INSTALLATION, OPERATION AND SERVICE OF BRISTOL'S SERIES 500 AND 534 ELECTRONIC FREE-VANE CONTROLLER

TABLE OF CONTENTS

	Page
PART I GENERAL	3
A. Description	3
B. Types of Control	3
C. How the Electronic Control Unit Works	4
D. How the Proportional-input Unit Works	4
PART II INSTALLATION	5
A. Unpacking and Mounting	5
B. Measuring System	5
C. Wiring	5
PART III OPERATION	5
A. How to Start Controllers	5
B. How to Start Controllers with Proportional-input Control	5
C. Checking and Adjusting the Control Point	7
D. Checking and Adjusting the Differential Gap	7
PART IV SERVICE	7
A. Checking the Tubes	7
B. Replacing a Control Unit	7
C. Servicing of Relay Contacts	7
D. How to Install Change Gears on Proportional-input Units	8
E. Repairs, Correspondence and Shipping	8

THE BRISTOL COMPANY WATERBURY 20, CONN.

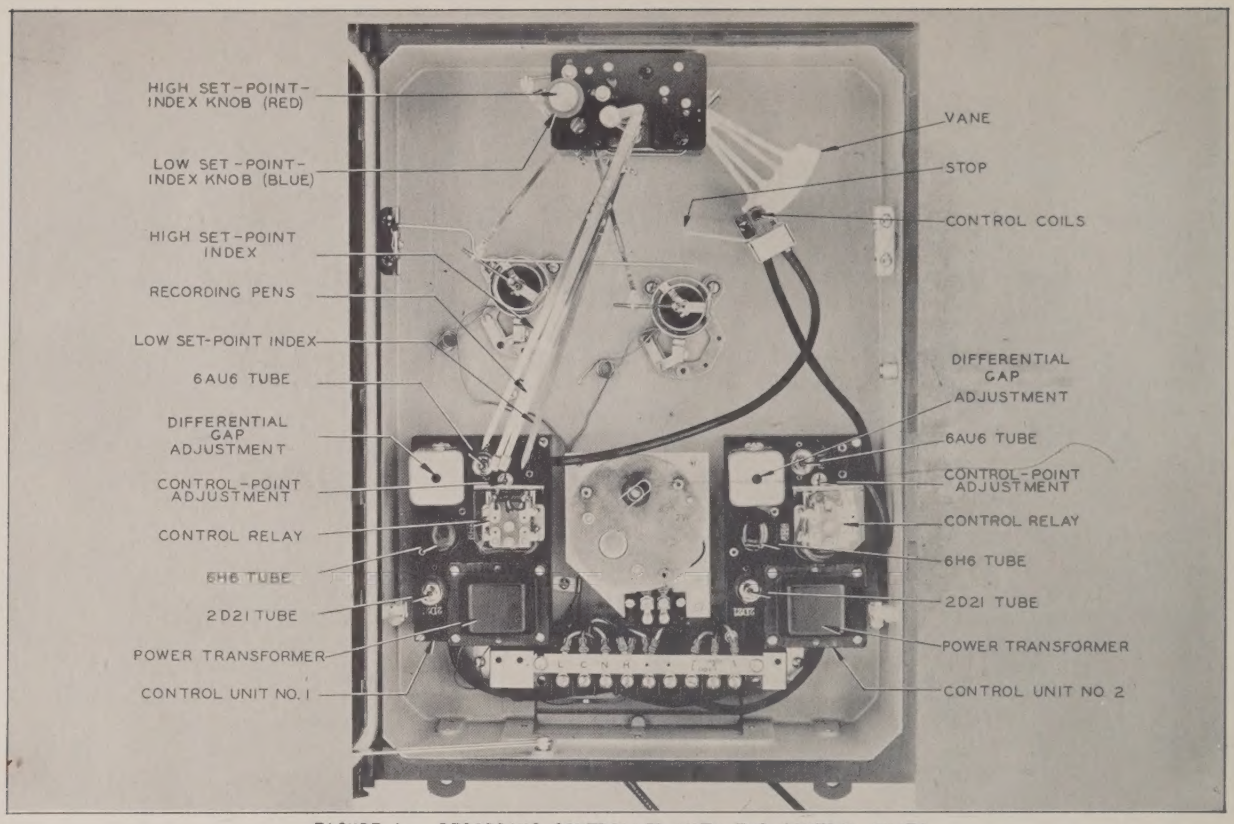


FIGURE 1. RECORDING CONTROLLER WITH TWO CONTROL UNITS

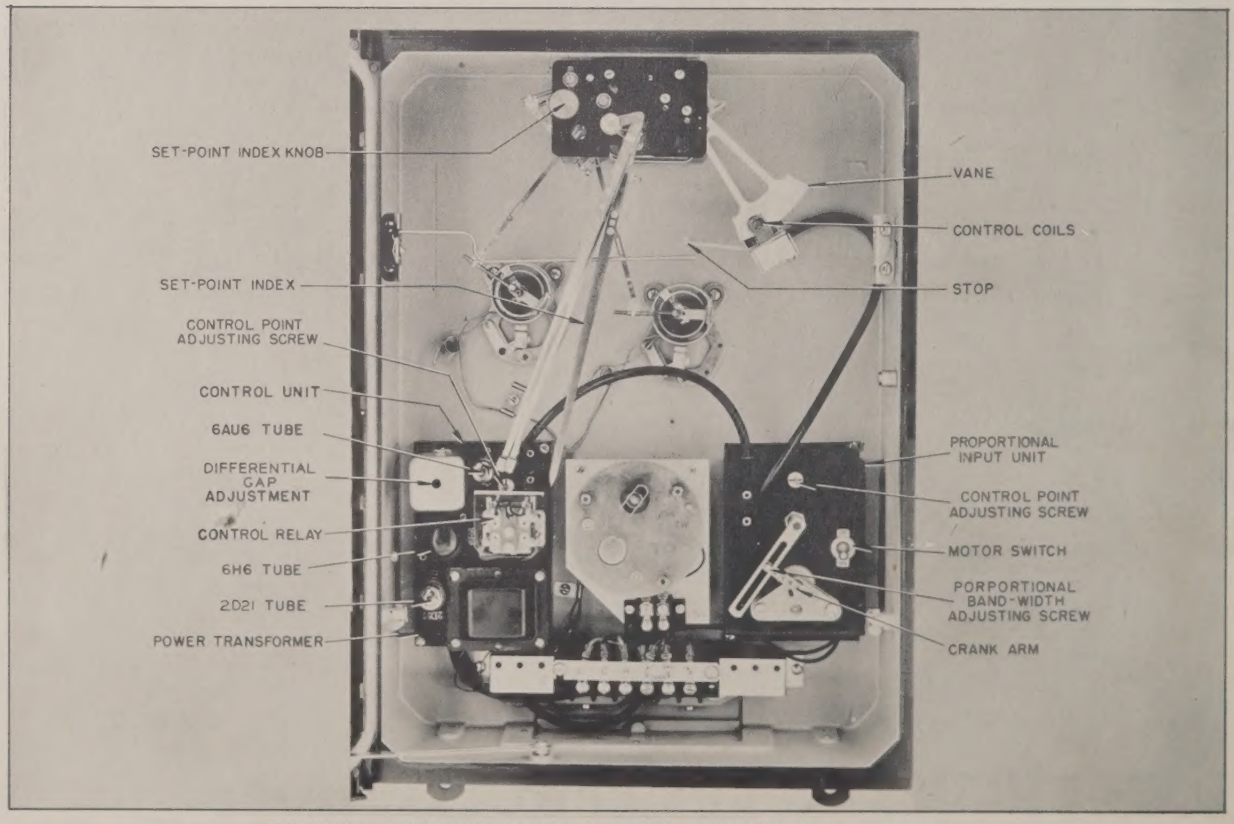


FIGURE 2. RECORDING CONTROLLER WITH PROPORTIONAL INPUT UNIT

Note: This instruction covers only the Electronic Free-vane Control System. See separate instructions covering the measuring system, recording system, etc., which are furnished as required.

PART I GENERAL

A. Description

The Bristol Electronic Free-vane Controller consists of a measuring system (temperature, pressure, flow, etc.) with the necessary indicating or recording components and one or two electronic control units as required.

Controllers with one control unit provide L, H or LH type control and are equipped with one set-point index. Instruments with one control unit may also be equipped with a proportional-input unit.

Controllers with two control units provide LOH or LNH type control and are equipped with two set-point indexes. Two-pen controllers with two control units are sometimes wired to provide an LH type control for each pen. Separate wiring diagrams are furnished to cover these applications.

The electronic units may also be used to operate alarm circuits in instruments such as Bristol's Metameter Receivers.

The electronic control unit and the proportional-input unit are especially adapted for easy installation, interchangeability and simplified service.

B. Types of Control

The Series 500 Electronic Controllers can be furnished with any one of seven standard types of control: L, H, LH, LOH or LNH, and L or H with proportional-input control. Special control circuits are also available on order.

1. L Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable back to the set point. When the measured variable goes above the set-point index, the "L" load is deenergized.

2. H Control. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable. When the measured variable is lower than the set-point index, the "H" load is deenergized.

3. LH Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable.

4. LOH Control. When the measured variable is lower than the low set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, both high and low loads are deenergized. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **off** band and is adjustable from 0 to 100% of the total range of the instrument.

5. LNH Control. When the measured variable is lower than the low set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, a **normal** control load is energized to maintain the normal value of the measured variable. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **normal** band and is adjustable from 0 to 100% of the total range of the instrument.

6. L or H Control with Proportional Input. This type of control is called "average-position action" in which the final control element is turned on and off continuously when the measured variable is within the control band. The ratio of **time on** to **time off** is directly proportional to the deviation of the measured variable from the set-point index. The set-point index usually locates the center of the control band. The control band is adjustable from 0 to 6% of the scale range.

Note: The load or loads may be

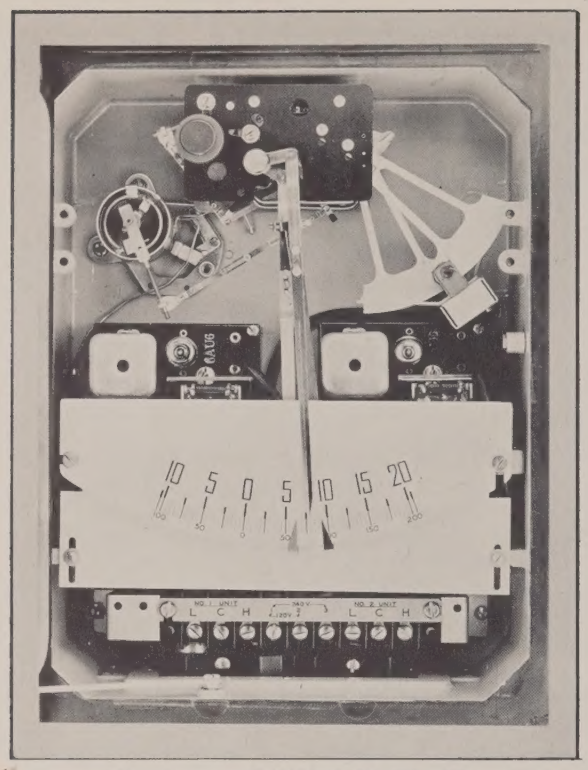


FIGURE 3. INDICATING CONTROLLER WITH TWO CONTROL UNITS

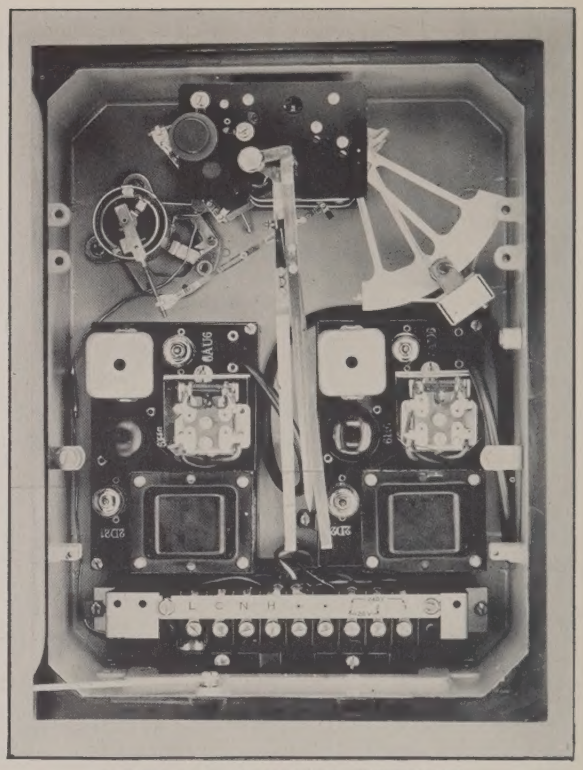


FIGURE 4. INDICATING CONTROLLER WITH TWO CONTROL UNITS

heater units, solenoid valves, coils of motor starters, relays, contactors, etc. Controllers with proportional-input control may be used as L, H or LH controllers merely by putting the band-width adjusting screw on the proportional-input unit in the zero-band position.

C. How the Electronic Control Unit Works

The measuring element of the instrument is connected to a differential mounting to actuate the pen or pointer and a vane. When this vane moves between two control coils, a change occurs in the electronic control circuit that actuates the control relay. The circuit is designed to have the control relay energized when the vane is out of the coils and deenergized when the vane is between the coils. A stop is provided on the control-coil assembly to prevent the vane from going completely thru the coils.

In case of failure of any of the tubes or of failure of the power supply to the instrument, the controller will operate as follows:

On L, H or LH controllers, the controller will operate as though the pen or pointer were above the set point, L circuit open, H circuit closed (control relay deenergized).

On LOH or LNH controllers:

1. If the low control unit fails and the high control unit is OK, the instrument will function as an "LH" controller.

2. If the high control unit fails and the low control unit is OK, the H circuit will close and the L and N circuits will open. This condition will remain until the fault has been corrected.

3. If both control units fail, operation will be the same as in 2 above.

D. How the Proportional-input Unit Works

The proportional-input unit is used together with a single electronic control unit.

The input unit consists of a variable capacitor operated by a Telechron motor. Because the variable capacitor is connected in parallel with the control coils, variation of this capacitance produces the same effect as motion of the vane between the control coils, energizing and deenergizing the control relay.

An adjustable inductance coil is connected across the variable capacitor for adjusting the location of the control point so that the control relay of the electronic control unit will operate when

the pen or pointer coincides with the set-point index in the 0% band position.

The slotted arm on the input unit has positions to give control-band widths of 0%, 1.5%, 3%, 4.5% and 6% of full range of the controller. These percentage values are approximate values because of certain differences between recorders, indicators and program controllers.

When the proportional band is adjusted to zero, the plates of the variable capacitor will remain stationary, the proportional-input unit will have no effect and two-position control will be produced.

When the control band is adjusted to 6%, the proportional-input unit will have its maximum effect.

The effect of moving the plates in the variable capacitor is to swing the control point back and forth once every revolution of the input unit.

The magnitude of this swing and the resulting control-band width depend on the setting of the adjustment mentioned above. As long as the value of the controlled variable is such as to hold the leading edge of the vane within this control band, the final control element will be opened and closed once every revolution. The proportion of opened time to closed time will then depend on the position of the vane edge within this control band. For all values of the controlled variable that are above or below the edges of this control band, the control valve (or other final control element) will be either fully closed or fully open.

PART II INSTALLATION

A. Unpacking and Mounting

See separate instructions furnished covering unpacking and mounting of the Series 500 instruments.

B. Measuring System

See separate instructions covering installation of the measuring system.

C. Wiring

Before making any connections to the instrument, determine what type of control you have (see paragraph B on page 3) and then select the correct diagram from those furnished with this instruction. Special diagrams will be furnished when required. The name plate of the instrument shows what voltage and frequency are to be connected to the a-c power terminals. Note that there are terminals for either 120 volts or 240 volts. Be sure to use the correct terminals. It is suggested that all wiring to the instrument be put in conduit.

Rating of Control Relay Contacts. The relay contacts in the control unit are limited to a non-inductive capacity of 15 amperes at 120 volts, 25, 50 or 60 cycles, 6 amperes at 240 volts, 25, 50 or 60 cycles, and 0.4 ampere at 120 volts d-c.

PART III OPERATION

A. How to Start Controllers

1. Turn instrument power supply on and allow approximately 30 seconds for tubes to warm up.
2. Move set-point index or indexes to the desired value on the chart or scale.
3. Turn load-circuit power supply on. Instrument will then begin automatic control.

B. How to Start Controllers with Proportional-input Control

Controllers with proportional-input control require several operational considerations in addition to those for the standard controller. These are the selection of the correct change gears for the proportional-input unit, the determination of the correct proportional-band width and the starting of the proportional-input unit.

1. Selection of the Correct Change Gears. Change gears are available for three different speeds of rotation of the crank arm: a 15-second cycle, a 30-second cycle and a 60-second cycle. Your proportional-input unit is provided with one set of gears as ordered. Orders that do

not specify any particular speed of rotation will be supplied with gears for a 30-second cycle.

The correct speed depends on the maximum speed with which the controlled variable can change. Use fast gear speeds for a process that can change quickly, such as a small capacity tank, furnace or vat with a relatively large input. Always use the slowest speed which will give satisfactory control. This prevents excessive wear on relays, valves, contactors, etc. However, if too slow a speed is used, the controlled variable will tend to cycle in phase with the proportional-input unit.

See paragraph D on page 8 for instructions on how to install change gears.

2. Determining the Proportional-band Width. The proportional band may be set at 0%, 1.5%, 3%, 4.5% and 6% of the full range of the instrument. This is done by moving the proportional-band-width adjusting screw to any desired position. These positions are shown in Figure 5.

To determine the correct band width for your process, proceed as follows:

First turn instrument power supply **on** and turn input-unit switch **off.** Put the band-width adjusting screw in the 6% position and then turn input-unit switch **on.** Move set-point index to the desired value on the scale. Turn load-

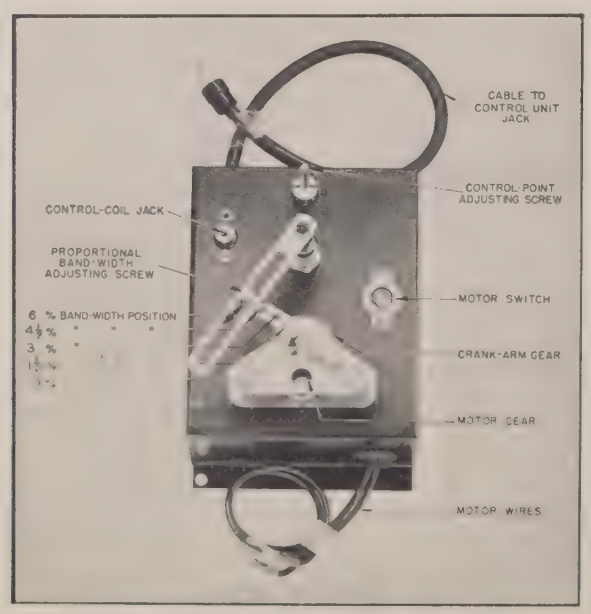


FIGURE 5. PROPORTIONAL INPUT UNIT

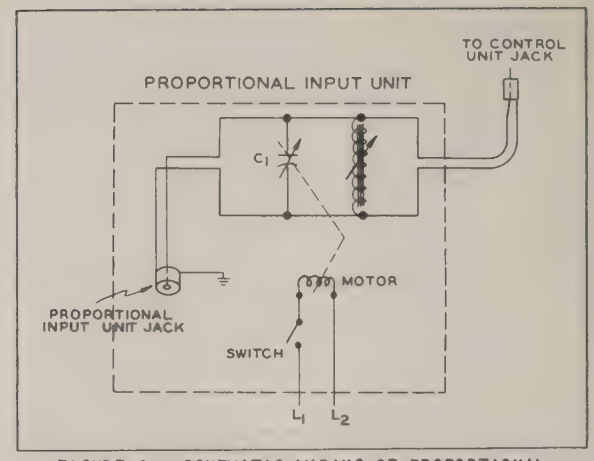


FIGURE 6. SCHEMATIC WIRING OF PROPORTIONAL INPUT UNIT

circuit power supply **on** and allow process to come to a steady condition. When the pen or pointer approaches the set point, automatic proportional control will begin. Observe the action of the pen or pointer for several minutes. The following conditions are possible:

a. The pen or pointer may come up to the control point and remain there. This indicates good control. However, it is desirable to have as narrow a proportional band as possible. Switch off the input unit and change the proportional-band width to 4.5%. Turn on the input unit and again observe the control action. If it is as stable as it was with the 6% band, continue to reduce the proportional-band width until undesirable cycling occurs. This will be indicated by oscillation of the pen or pointer from one side of the control point to the other. To eliminate this oscillation, change the proportional-band width to the next higher value and leave it there.

b. The pen or pointer may cycle in phase with the crank arm when the proportional-band width is set at 6%. This would indicate that the crank-arm speed is too slow for the particular application. Change to a faster speed (see paragraph D on page 8).

c. The pen or pointer may cycle at a frequency different from the crank-arm frequency (usually much slower). This would show that the proportional band is too narrow and that the application of the controller to this particular process was incorrect or that valve sizes, pipe sizes, etc., should be changed.

C. Checking and Adjusting the Control Point

1. Controllers without Proportional-input Control. The control relay should operate when the pen or pointer coincides with the set-point index. This adjustment is very accurately made at the factory and seldom requires readjustment. If readjustment is necessary, turn the control-point adjusting screw (see Figure 1) a little to the left or right as required.

2. Controllers with Proportional-input Control. Remove plug-in cables from control unit and input unit. Plug cable from the control coils directly into the control unit and check the control point exactly as in paragraph 1 above. Then replace plug-in cable from control coils to input unit and plug-in cable from input unit to control unit. Adjust the proportional-band-width adjusting screw in the zero hole of the crank arm so that the slotted arm remains perfectly vertical. Again check the control point exactly as in paragraph 1 above. If any adjustment is necessary, adjust the control-point adjustment on the proportional-input unit (not the control-point adjustment on the control unit).

D. Checking and Adjusting the Differential Gap

Differential gap (dead zone) applying to two-position controller action (LH control) is the smallest range of values thru which the controlled variable must pass in order to move the final control element in succession to both of its fixed positions. This zone is set at the factory at approximately .003" and seldom requires readjustment. However, when the instrument is subject to excessive vibration, it may be necessary to widen the differential gap in order to prevent erratic operation of the controller.

To check the width of the differential gap, move the set-point index slowly past the pen or pointer (both upscale and downscale) and note when the control relay operates. If readjustment is required, it may be done by adjusting the differential-gap adjustment (see Figure 1) with a screwdriver. Turn the adjusting screw counterclockwise to widen the differential gap or clockwise to narrow the gap. Check the control point after any change in the differential gap.

Control units shipped after June 1, 1954 permit a differential-gap adjustment up to .012". Control units made previous to this date have a maximum gap of approximately .004". These older units may be easily altered in the field to permit a wider differential gap by adding a 270,000 ohm resistor (Bristol Part 90557) across the discriminator transformer secondary (lugs A and C on schematic wiring diagram)

PART IV SERVICE

A. Checking the Tubes

If your controller fails to function properly and there is no obvious fault (such as power failure, measuring-element failure, etc.), check the electronic tubes by replacement (a spare set should always be kept on hand). Remove one tube at a time from the control unit and replace it with one known to be good. Allow 30 seconds for the tube to warm up. When operation is restored, the original good tubes may be reinstalled. If normal operation is not obtained with a complete new set of tubes, the control unit should be replaced by one known to be good. When replacing a unit, leave the old tubes in the old unit.

Note: The vacuum tubes used are standard types and may be purchased in any radio supply store.

B. Replacing a Control Unit

To remove a control unit, disconnect the wires connecting the unit to the terminal block and remove the plug-in cable from the control coils or input unit as the case may be. After removing the mounting screws, the unit may be easily removed from the case. Install the new unit, replace and tighten the mounting screws and connect the wires as per wiring diagram.

After the new unit has been installed, check its control point and differential gap as outlined in Part III, paragraphs C and D.

C. Servicing of Relay Contacts

The relay contacts should be cleaned and burnished (with crocus cloth) as often as experience shows it to be necessary.

Crank-arm Rotation (Seconds)	Crank-arm Gear		Motor Gear	
	Number Of Teeth	Part Number	Number Of Teeth	Part Number
15	30	67856	30	67856
30	40	47693	20	47696
60	48	45319	12	53490

FIGURE 7. TABLE OF GEARS FOR INPUT UNIT

D. How to Install Change Gears on Proportional-input Units

To install new change gears, remove the proportional-band adjusting screw (note which hole it is in), swing the slotted arm out of the way and take off the top bearing plate (including the crank arm, shaft and gear). Remove the crank-arm gear and motor gear. See Figure 7 for identification and listing of gears.

For a 15-second cycle the two change gears have an equal number of teeth (30). For the 30- and 60-second cycle the larger gear always goes on the crank-arm shaft. After sliding the new gears on their respective shafts, replace the top bearing plate. Position the crank-arm gear on its shaft so that it clears the bottom bearing plate by at least 1/16". Tighten its setscrew. Then position the motor gear so that it meshes properly with the crank-arm gear. Tighten its setscrew. Replace the proportioning-band adjusting screw in the same hole from which it was originally removed.

E. Repairs, Correspondence and Shipping

If your electronic controller cannot be repaired with the information furnished in this instruction, it should be shipped to the nearest Bristol Company Branch or Main Factory for repair or replacement. **Do not** ship instrument to Branch Offices.

Send all parts for repair or exchange to Branch or Main Factories only, never to Branch Offices. Identify your shipment fully, including your exact return address and repair order number.

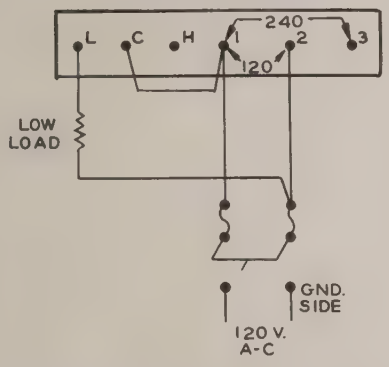
Send all correspondence and orders to the nearest Branch Office. Addresses and phone numbers of Bristol's Field Organization are listed on last pages of all instruction books.

Be sure to state model and serial number of instrument in all orders and correspondence.

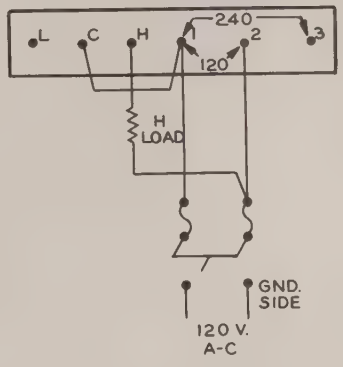
The Bristol Company
Waterbury 20, Conn.

Printed in U.S.A.

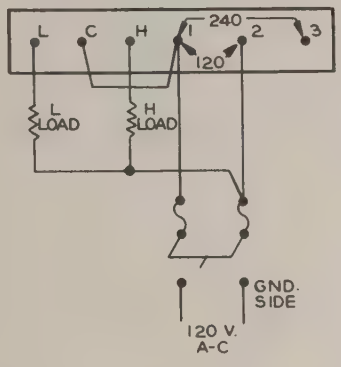
L-TYPE CONTROL



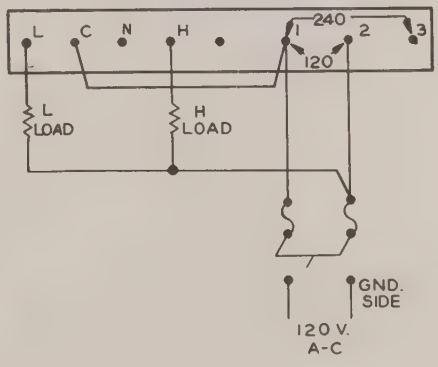
H-TYPE CONTROL



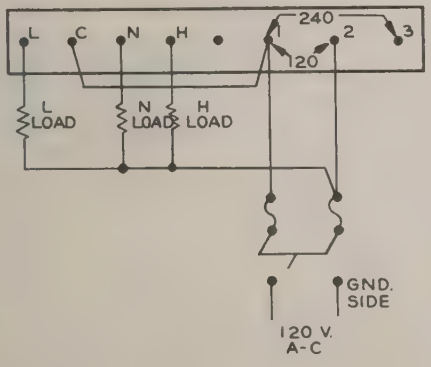
LH-TYPE CONTROL



LOH-TYPE CONTROL



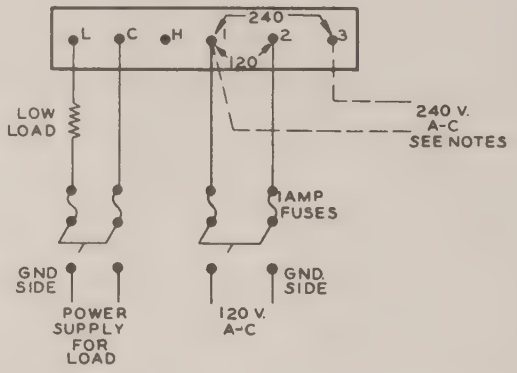
LNH-TYPE CONTROL



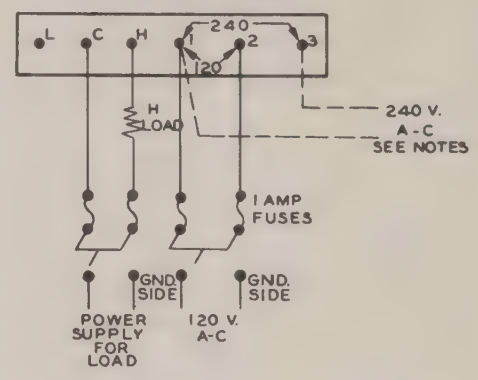
NOTES:-
1. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
2. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 6 AMPS. AT 240 V. A-C

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH COMMON 120 V. A-C SUPPLY FOR INSTRUMENT AND LOADS

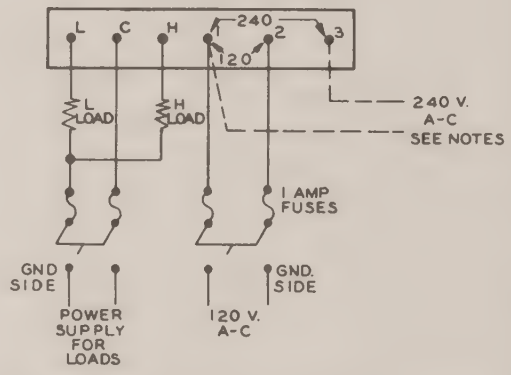
L-TYPE CONTROL



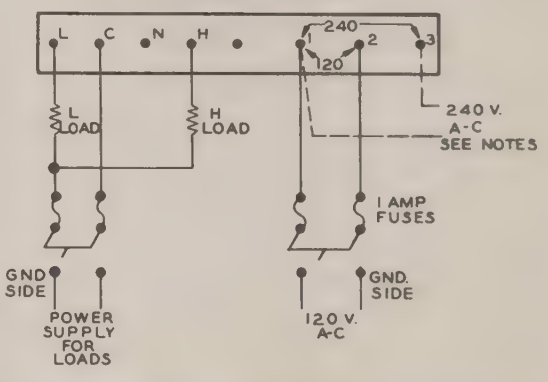
H-TYPE CONTROL



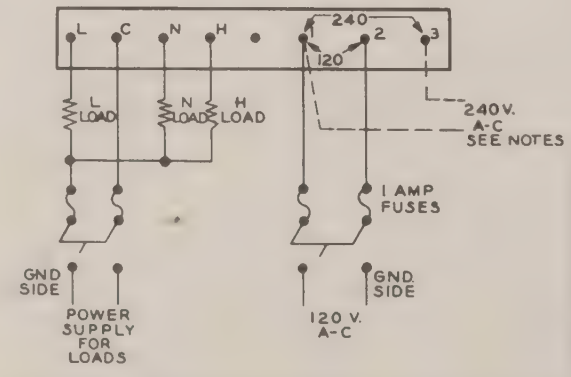
LH-TYPE CONTROL



LOH-TYPE CONTROL



LNH-TYPE CONTROL

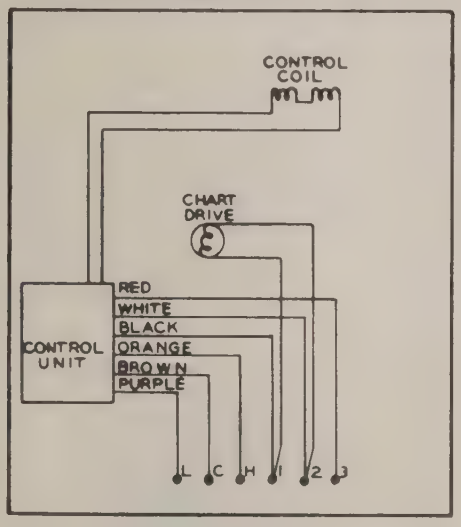


NOTES:-

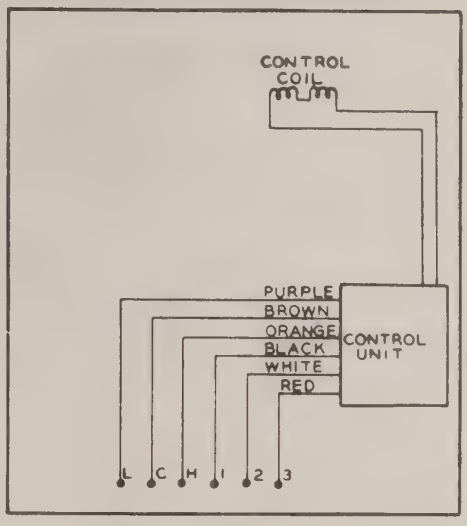
1. THE POWER SUPPLY TO THE CONTROLLER MAY BE EITHER 120 VOLTS OR 240 VOLTS A-C.
2. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
3. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 6 AMPS. AT 240 V. A-C.

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH SEPARATE SUPPLY FOR INSTRUMENT AND LOADS

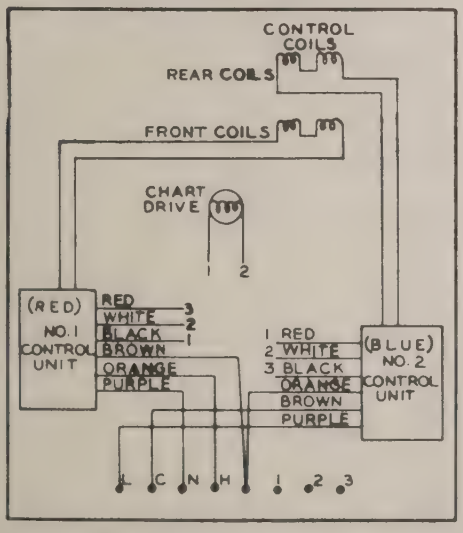
RECORDER
WITH SINGLE CONTROL UNIT



INDICATOR
WITH SINGLE CONTROL UNIT



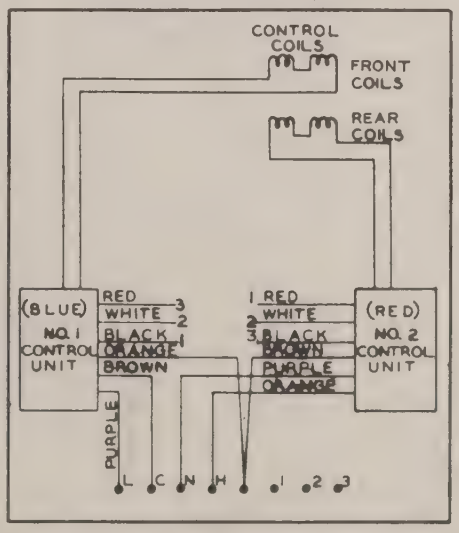
RECORDER
WITH TWO CONTROL UNITS



NOTE: REAR VANE LEADS FRONT VANE INTO CONTROL COILS.

RECORDER
WITH FIXED 2% BAND & 2 CONTROL UNITS

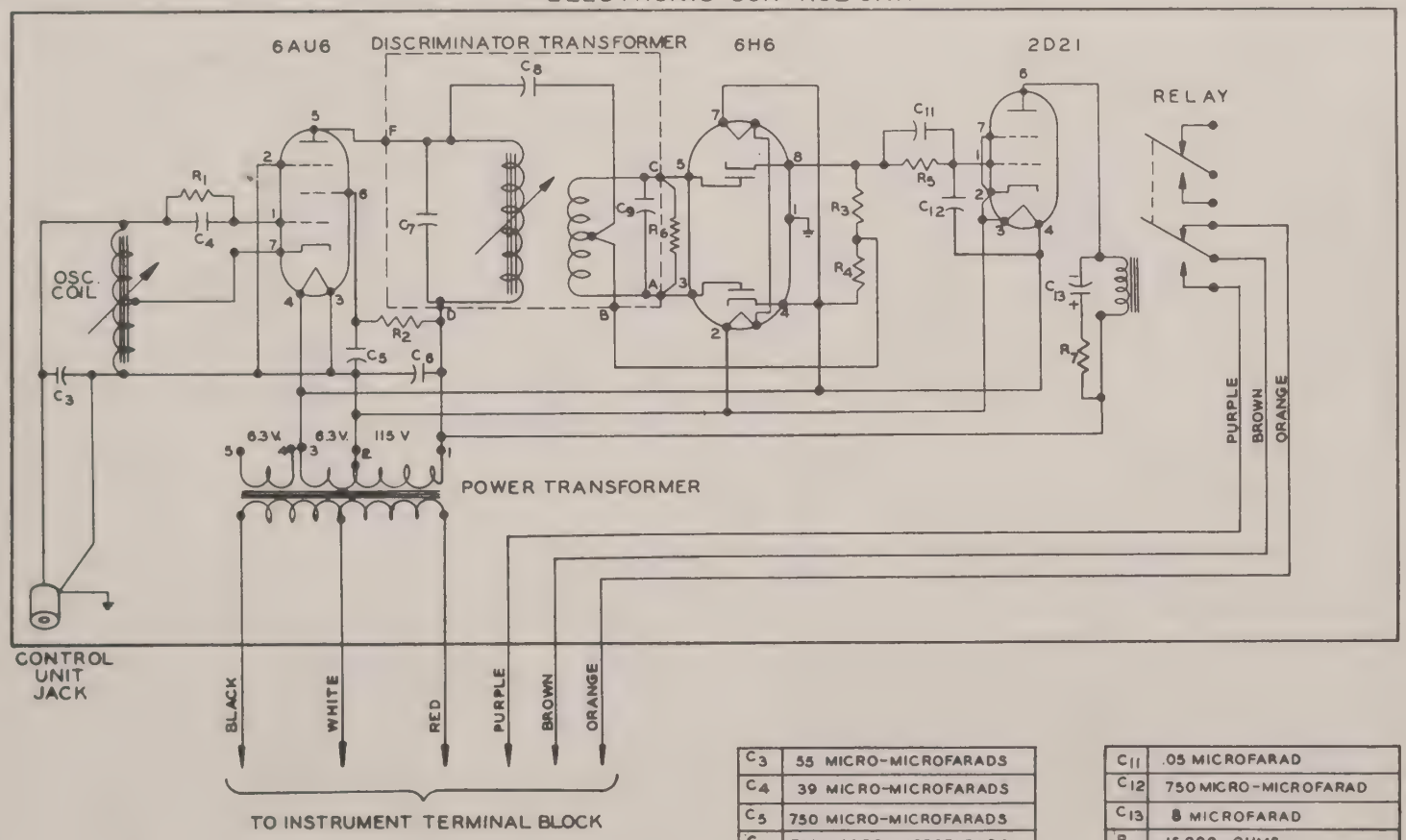
INDICATOR
WITH TWO CONTROL UNITS



NOTE: FRONT VANE LEADS REAR VANE INTO CONTROL COILS.

INTERNAL WIRING OF STANDARD SINGLE & DOUBLE CONTROL UNIT SERIES 500 ELECTRONIC CONTROLLERS EQUIPPED WITH 1959 DESIGN DIFF. PEN MOUNTINGS FOR SERIAL NO. 719296 & ABOVE

ELECTRONIC CONTROL UNIT



C_3	55 MICRO-MICROFARADS
C_4	39 MICRO-MICROFARADS
C_5	750 MICRO-MICROFARADS
C_6	750 MICRO-MICROFARADS
C_7	SUPPLIED WITH
C_8	DISCRIMINATOR
C_9	TRANSFORMER

C_{11}	.05 MICROFARAD
C_{12}	750 MICRO-MICROFARAD
C_{13}	8 MICROFARAD
R_1	15,000 OHMS
R_2	47,000 OHMS
R_3	150,000 OHMS
R_4	270,000 OHMS
R_5	2.2 MEGOHMS
R_6	270,000 OHMS
R_7	270 OHMS

SCHEMATIC WIRING OF CONTROL UNIT

THE BRISTOL COMPANY
Waterbury 20, Conn., U.S.A.

Instruction No. T8000A
Issued 2/61

INSTRUCTION NO. T8000A

(REPLACES ISSUE OF 6/53)

UNPACKING, INSTALLATION AND SERVICE OF FILLED SYSTEM THERMOMETERS

Note: This instruction covers only the temperature measuring system. See separate instructions for installing the case, operation of the recording or controlling system, etc.

TABLE OF CONTENTS

	Page
PART I GENERAL	2
A. Description of Filled System Thermometers	2
B. Name Plate Data	2
C. Type of Bulb to Use	3
PART II INSTALLATION	3
A. Installing the Case	3
B. Installing Tubing	3
C. Installing Bulbs	3
1. Assembly	3
2. Amount of Immersion	5
3. Plain Bulbs	5
4. Union Bulbs	5
5. Well Bulbs	5
6. Bendable Extension	5
7. Installation Thru Conduit and Partitions	5
8. Pressure Limits of Convertible Bulb	5
D. Factors Affecting Thermometer Performance	6
1. Bulb Location	6
2. Bulb and Well Conduction	6
E. Over and Under Range Protection	7
F. Bulb Elevation Corrections	7
G. Installation of Certain Special Bulbs	12
1. Atmospheric Temperatures	12
2. Averaging Bulbs	12
3. Electroplating Baths and Tanks	12
PART III OPERATION	12
PART IV SERVICE	12
A. Checking and Calibrating	12
1. Testing for Friction	12
2. Cautions for Calibration or Checking	13
3. Checking and Calibrating Procedure	13
4. Calibrating Temperatures	17
B. Replaceable Thermometer Systems	17
1. Changing Ranges	17
2. Standby Thermometer Systems	17
3. How to Remove Thermometer Systems	17
4. How to Install Replacement Thermometer Systems	17
5. How to Order Replacement Thermometer Systems	18
C. Lubratication and Cleaning	18
D. Repairs, Correspondence and Shipping	18

THE BRISTOL COMPANY WATERBURY 20, CONN.

Note: This instruction applies to all Class 1, 2 and 3 case or fully compensated, single and multiple thermometer systems as used in indicating, recording and controlling thermometers, or as temperature pens in pressure gauges, flowmeters, etc.

If your instrument is an indicating instrument, please ignore any reference herein to chart, pen, etc.

PART I GENERAL

A. Description of Filled System Thermometers

The thermometer system consists of the helical pressure element, connected by flexible capillary tubing to a metal chamber or bulb (see Figure 1). The bulb, tubing and pressure element form a sealed pressure system which is factory filled with a fluid dependent upon the class of thermometer system. Bristol Company thermometer systems are classified into three main categories and are in accord with the standards set up by the Scientific Apparatus Makers Association:

Class 1 - Liquid filled systems
Class 2 - Vapor pressure systems
Class 3 - Gas filled systems

This sealed pressure system must never be opened or broken because the filling fluid will leak out, even thru the most minute crack or hole, making the system inoperative.

Pressure changes or expansion of the filling fluid occurs when temperatures at the bulb change. These changes are transmitted by the capillary tubing to the pressure element, causing the element to coil or uncoil, thus moving the pen or pointer thru the connecting linkage.

B. Name Plate Data

The name plate mounted inside the door carries the following information:

1. Model Number. The model number is given in full. The class of thermometer system is given by the number following the first dash after the basic model number. For example, Model No. 1T500-2B-E4. The "2B" indicates the class of thermometer system. A complete breakdown of the three classifications follows:

1A - Class 1, liquid filled system, fully compensated.

1B - Class 1, liquid filled system, case compensated.

2A - Class 2, vapor pressure system, to operate with the measured temperature above the temperature of the rest of the thermal system.

2AL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature above the temperature of the rest of the thermal system.

2B - Class 2, vapor pressure system, to operate with the measured temperature below the temperature of the rest of the thermal system.

2BL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature below the temperature of the rest of the thermal system.

2C - Class 2, vapor pressure system, to operate with the measured temperature above and below the temperature of the rest of the thermal system.

2CL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature above and below the temperature of the rest of the thermal system.

2D - Class 2, vapor pressure system, dual filled, to operate with the measured temperature above, below and at the temperature of the rest of the thermal system.

2DL - Class 2, vapor pressure system, dual filled, linear conversion, to operate with the measured temperature above, below and at the temperature of the rest of the thermal system.

3A - Class 3, gas filled system, fully compensated.

3B - Class 3, gas filled system, case compensated.

2. Bulb Number. The first three number groups give the bulb specifications, the last group gives the length of the tubing in feet.

3. Bulb Elevation. (Class 2 only) If the thermometer has been ordered corrected for levels, the elevation of the bulb above or below the instrument, measured to the bottom of its case, will

be given. If these spaces are blank, no correction has been made. See paragraph F on page 7 for full explanation of correction for levels.

C. Type of Bulb to Use

1. Plain Bulbs. (See Figure 2) Plain bulbs can be used where a pressure tight joint is not necessary.

2. Union Bulbs. (See Figure 3) Union bulbs are used where a pressure tight joint is necessary.

3. Well Bulbs. (See Figure 4) Bulbs with wells are used for the following reasons:

a. Protect bulb from corrosion.

b. Protect bulb from high pressure, mechanical damage or erosion.

c. Permit removal of bulb from process without necessity of turning process off. Wells should always be used where process cannot be shut down at any time for removal of bulb for check, calibration, repair or replacement.

PART II INSTALLATION

Caution: Handle thermometer tubing and bulb with care. Do not twist, kink or strain tubing. Do not bend it sharply. Never cut tubing or disconnect it from bulb or case coupling. Never use tubing to carry or support the instrument.

A. Installing the Case

See separate instructions furnished, covering unpacking and mounting of the instrument. Thermometers must be mounted exactly plumb. Use a spirit level on inside bottom of case, or a plumb bob along front edge. Locate case to avoid extremes of temperature.

In flush mounting bottom connected thermometers on thick panels, it may be necessary to increase the length of panel cutout to provide clearance for tubing.

B. Installing Tubing

Uncoil tubing and carefully straighten it out without twists or kinks. Do not cut it under any circumstances. Do not bend tubing at less than a 3" radius. The tubing must be protected from mechanical damage, crushing, abrasion, strain or movement. Tubing may be strung thru conduit if bulb is small enough to pass thru it. Tubing may be supported on any wall, beam, etc., by fastening every 2 feet with clips, staples, etc. Tubing may be tied or taped to unheated pipes, columns, etc.

Do not subject tubing covered with polyvinyl chloride plastic to temperatures over 160°F (71°C) or it will melt.

Class 1 and 3 uncompensated tubing must be installed to avoid extremes of temperature. Keep tubing away from hot or cold pipes, ovens, chimneys, hot or cold air ducts, open windows, direct sunlight, etc. Class 2 tubing is relatively unaffected by ambient temperatures.

Coil any excess of tubing in an 8" to 12" coil near the instrument and tape it in place. **Do not cut off excess tubing.**

C. Installing Bulbs

The Bristol convertible thermometer bulb can be easily changed to plain, union or well type bulb by exchanging union and well parts. Thus, one basic bulb can fulfill requirements of almost all processes. This feature permits standardization of thermometer systems to a single basic bulb specification throughout an entire plant, which allows quick replacement of a faulty system by standardized standby thermometers.

1. Assembly. Figure 5 shows correct order of part assembly. To change from plain (Figure 2) to union bulb (Figure 3), the parts shown in Figure 5 are added to the plain bulb. To change from union to well bulb, replace union bushing with the well.

All parts can be slipped over the sensitive portion of bulb, except the packing and glands which are split so they can be opened to slip over the extension. Halves of split glands are held together by spring-wire gland clips. All bulb conversion parts are specified in "Parts List for Thermometer Accessories" included with each instruction book.

Caution: In tightening packing nut, be very careful not to mar the polished seat of union plug. A damaged union seat

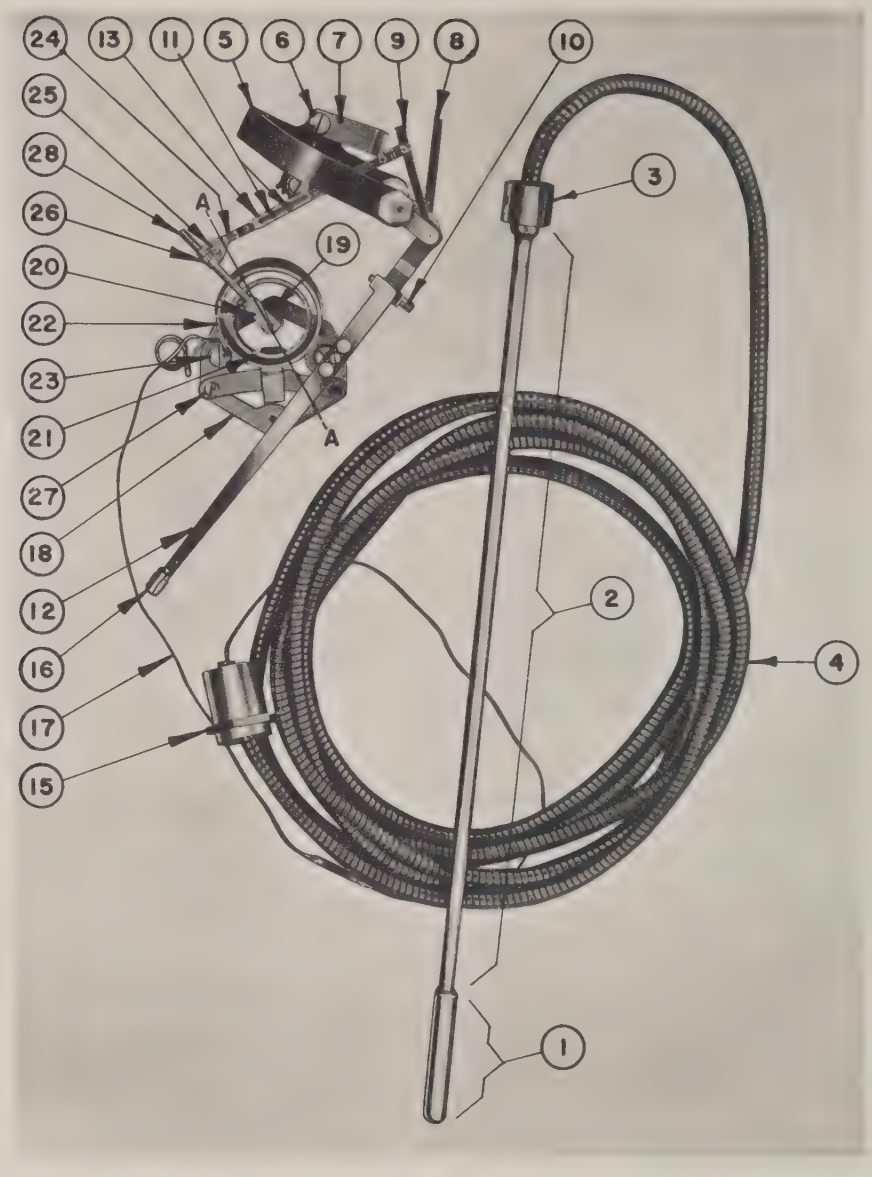


FIGURE I TYPICAL THERMOMETER SYSTEM

CODE TO FIGURE I

1. Sensitive portion of bulb
2. Extension
3. Connector
4. Flexible armor
5. Pen mounting
6. Pen mounting screws
7. Overrange pen stop (optional)
8. Pen stop lever (optional)
9. Pen shaft lever
10. Point micro adjuster
11. Connecting link adjustment screws
12. Pen arm
13. Connecting link
15. Case connection fitting
16. Recording pen
17. Capillary tubing
18. Element mounting bracket
19. Split hub setscrew
20. Split hub
21. Bimetallic case temperature compensator (not used in Class 2 or fully compensated systems)
22. Thermometer pressure element
23. Element mounting-bracket screws
24. Connecting link tab
25. Span adjuster lock screw
26. Span adjuster
27. Element mounting screws
28. Threaded lever

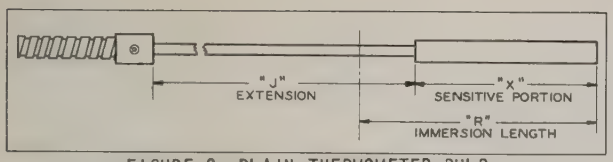


FIGURE 2 PLAIN THERMOMETER BULB

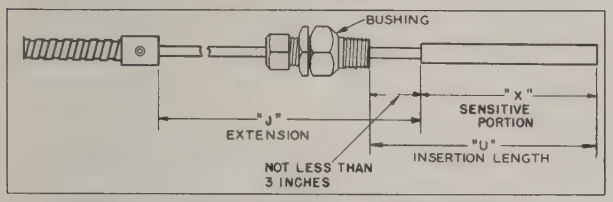


FIGURE 3 UNION CONNECTED THERMOMETER BULB WITH BUSHING

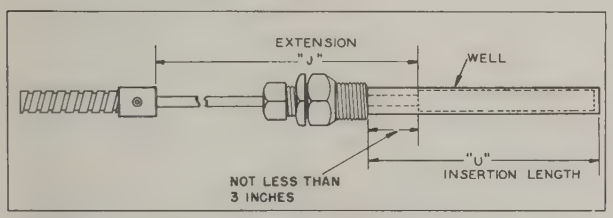


FIGURE 4 UNION CONNECTED THERMOMETER BULB WITH WELL

will leak. Use only a flat high quality open-end wrench of exact size as hex section of the union plug. **Do not use pipe or monkey wrenches.**

2. Amount of Immersion. Convertible bulbs are factory calibrated with sensitive portion "X" and 3 inches of extension "J" covered by test bath. **The entire sensitive portion "X" of bulb plus 3 inches of extension "J" must be covered by the medium being measured.** If this is not done, the thermometer will not read correctly. If more than 3 inches of the extension is immersed in the medium being measured, slight errors may occur in some types of systems. If specified on the order, convertible bulbs will be calibrated with any length of extension immersed.

Where the amount of immersion is constantly changing, the bulb should be calibrated for the average immersion. See Part III, paragraph A for full calibrating instructions.

Caution: Do not immerse flexible armor even momentarily in corrosive mediums, for the medium will penetrate joints in armor and destroy the capillary tubing.

3. Plain Bulbs. Plain bulbs can be most easily held by clamping at the bulb connector (see Figures 6, 7, 8 and 10). They can be suspended by wire or light chain or slipped into protection wells (see Figure 11).

4. Union Bulbs. Union bulbs can be installed thru a tank or oven wall as in Figures 9 and 12, or in pipe elbows or tees as in Figure 14 or 15. To install, insert union bushing in the process and screw up tight. Then, insert bulb and screw up jam nut tight, being careful not to twist tubing as jam nut is turned.

Caution: Be careful not to mar the seat on the union plug. A damaged seat will leak. Do not use toothed pipe wrenches.

5. Well Bulbs. Well bulbs can be installed in a tank wall, pipe elbow or tee, see Figure 13 or 16. To install, screw well tightly into process. Then, insert bulb into well and tighten jam nut, being careful not to twist tubing as nut is turned.

6. Bendable Extension. The 1/4 inch diameter extension (J in Figure 2 or 5) is standard in 10, 30 and 60 inch lengths. This extension can be bent, either inside or outside the process to clear pulleys, levers, stirring paddles, sliding doors, etc., to suit the installation. Minimum radius of bend must be not less than 1 inch. Bend extension around a pipe of the proper diameter to avoid flattening the extension. See Figures 7, 9, 10 and 11 illustrating the use of the bendable extension feature.

7. Installation Thru Conduit and Partitions. It is possible to install tubing thru 3/4 inch conduit pipe for protection, or to pull tubing thru 3/4 inch holes in partitions or floors because all union and well parts can be removed from convertible bulbs, leaving as the largest part on all but a few types the 3/4 inch diameter connector.

8. Pressure Limits of Convertible Bulb

a. Union connected bulb with bushing can be used with ample safety factor up to 200 pounds per square inch (14.0 kilograms per sq. cm.).

b. Wells can be safely used up to the following:

	P.S.I.	K/SQ. CM.
Bronze Wells	500	35.0
Stainless Steel Wells	750	52.6

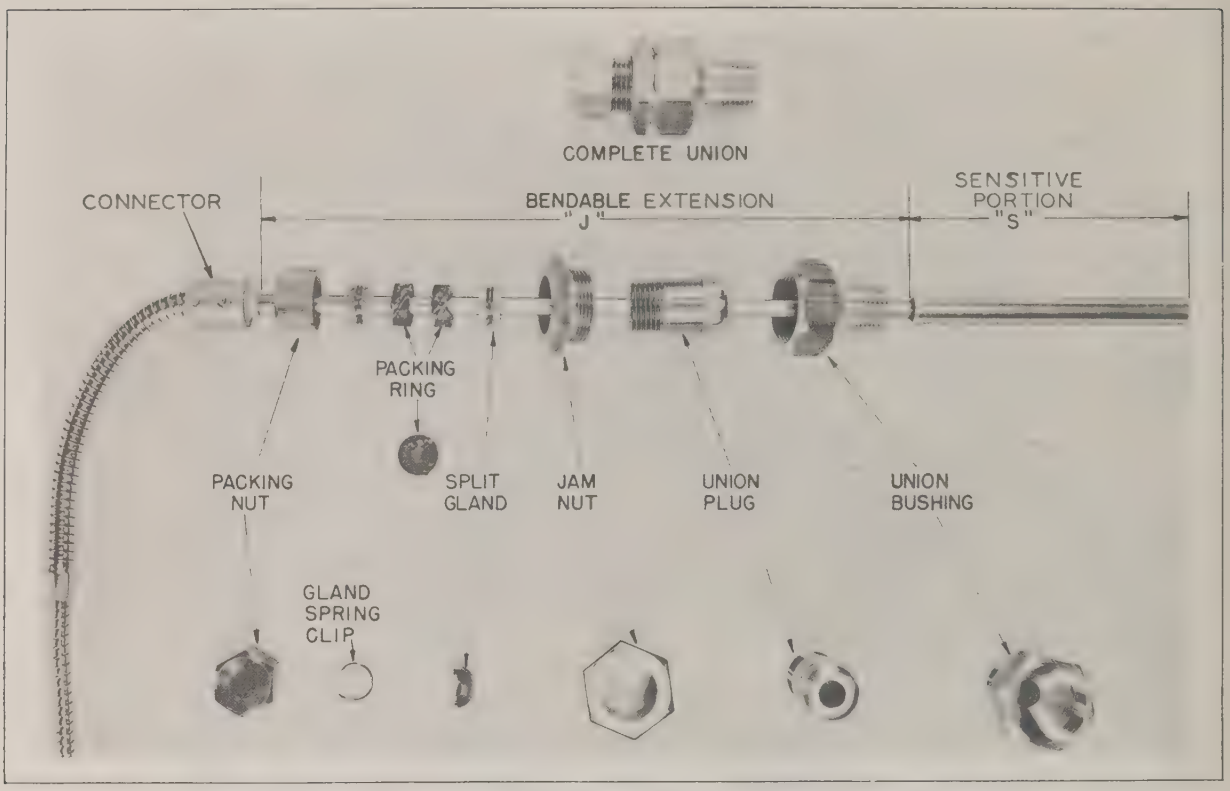


FIGURE 5 BRISTOL CONVERTIBLE BULB SHOWING CORRECT ORDER OF PARTS ASSEMBLY

D. Factors Affecting Thermometer Performance

The following considerations are especially important where temperature critical processes are involved, and for controlling thermometers:

1. Bulb Location

a. Representative Temperatures. In selecting the bulb location, consider what temperature of the process you want to measure, i.e., maximum, average, minimum, or input, output or interior temperature. Interior temperatures of processes, such as ovens, tanks, etc., may vary widely from point to point. Of first importance is locating the bulb so that it acquires the temperature it is desired to measure. A test to find this location can be made by moving the bulb from point to point and observing readings before making a permanent installation.

Keep bulbs away from cooling or heating duct openings or heating or cooling coils. Keep bulb away from the extreme top or bottom of ovens, rooms, etc., unless the temperature of these points is desired.

b. Circulation. Turbulence of the measured medium around the bulb should be as high as possible to increase the rate of heat transfer. Avoid locating bulbs in dead spaces, corners, dead end pipes or spots shielded from circulation. Avoid locating bulb so near the bottom of the tank or kettle that it might be partially covered by sludge or sediment.

Place bulbs near paddles, blowers, etc. Place bulbs in pipes or ducts at right angles to the flow (see Figures 13, 15 and 16).

c. Radiation Error. This is an important and usually overlooked consideration. Avoid placing bulbs where high temperature radiation from unshielded electric or steam heating coils can strike them. Avoid placing bulbs close to cold surfaces such as an uninsulated oven wall. If bulbs must be so located, place a piece of asbestos board or sheet metal between the bulb and the hot or cold surface (see Figure 7).

In general, locate the bulb to obtain good circulation, but not in the direct path of the heating or cooling agent.

2. Bulb and Well Conduction. Protec-

tion of bulbs in wells is accomplished only by great decrease in speed of response of the bulb (loss of responsiveness may be as high as 30 to 1).

The insulating effect of the dead air space between bulb and well cuts down the rate of heat transfer very much. Therefore, bulbs should fit very snugly into wells. A worthwhile increase in bulb response can be had by filling space between bulb and well with a highly conductive medium, such as water, oil, glycerine, graphite grease, mercury (only in all steel combinations), etc., depending upon the temperatures.

E. Over and Under Range Protection

(Refer to Figure 1.) As the bulb temperatures vary, internal pressures of the thermometer system change, causing the pressure element to coil or uncoil, actuating the linkage and pen arm. Considerable force is developed by the pressure element. If the bulb temperature goes above the upper limit of the temperature range or under the lower limit, the pen will attempt to follow and be swung off the chart at either end. This pen motion would eventually be stopped by the chart hub or the side of the case, probably bending the pen arm or linkage, destroying the calibration of thermometer.

To protect pen arm and linkage against such damage, adjustable stops (7) are provided to limit pen travel to little more than full range. Connecting link (13) is provided with a compression and expansion spring (14) which permits pressure element (22) to deflect after lever (8) strikes stop (7).

Bristol thermometers will be supplied with this over range and/or under range protection when so ordered. Even with such protection to the pen and linkage, the pressure element may be extended beyond its elastic limit and its calibration destroyed by excessively large over or under range temperatures. The maximum possible limits of over and under range temperature protection vary with the class of system, the range, length of tubing and ambient temperature. Please consult Sales Engineering Dept. at Waterbury factory for such data.

Caution: Never subject a thermometer bulb to temperatures over or under its range unless its system is protected. It is often overlooked that this precaution applies to many thermometers of high partial range, while instrument is in storage or shipment.

F. Bulb Elevation Corrections (Class 2 Systems Only)

(See Figure 18.) In the majority of thermometer installations, the bulb is at higher temperatures than the tubing so that the tubing will be filled with the liquid (all vapor will be in bulb). When the bulb is mounted at a level above or below the thermometer case, the weight of this liquid in vertical portions of the tubing adds to or subtracts from the pressures in the element. Because pressures in vapor filled systems are low, this plus or minus head of liquid ("h" in Figure 18) may cause a serious error in temperature readings which must be compensated for.

When bulb is mounted above the case, the weight of the liquid in the tubing will add to the pressure measured by the element, causing the thermometer to read high. To read the correct bulb temperature, the thermometer reading must be "set back".

When bulb is mounted below the case, the weight of the liquid in the tubing will subtract from the pressure measured by the element, causing the thermometer to read low. Then to read the correct bulb temperature, the thermometer reading must be "set up".

When the bulb is always colder than the tubing (bulb is always below ambient temperature), all of the fluid will condense in the bulb, leaving the tubing filled with vapor and no correction for difference in bulb and case level will be necessary (except in the dual filled Class 2D systems).

When the bulb is sometimes colder and sometimes hotter than the tubing (bulb sometimes above and below ambient temperature), the tubing will be sometimes filled with liquid and sometimes filled with vapor so that corrections for difference in bulb and case level are impossible with a Class 2C temperature system. Class 2C systems will be accurate both above and below ambient temperatures only when the bulb is approximately at the same level as the case.

When so ordered, Class 2 thermometers will be factory calibrated to correct for any specified bulb elevation. If a thermometer has been so corrected in the factory, its name plate will list the bulb elevation in feet. The difference

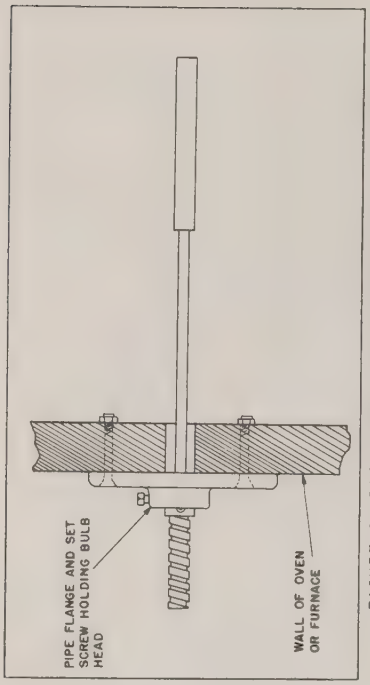


FIGURE 6 PLAIN BULB INSTALLED IN WALL OF OVEN

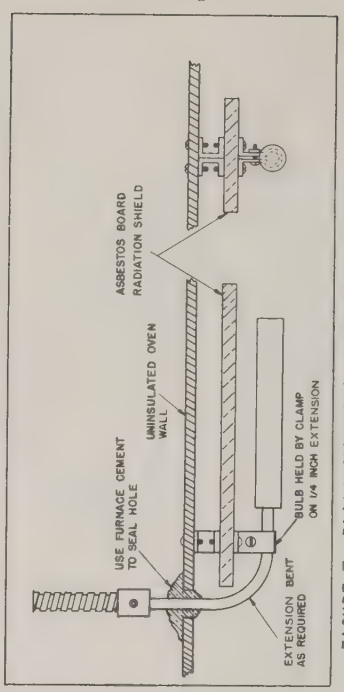

ASBESTOS BOARD RADIATION SHIELD
UNINSULATED OVEN WALL
USE FURNACE CEMENT TO SEAL HOLE
BULB HELD BY CLAMP ON 1/4 INCH EXTENSION
EXTENSION BENT AS REQUIRED

FIGURE 7 PLAIN BULB CLAMPED TO WALL OR ROOF OF OVEN SHOWING USE OF RADIATION SHIELD.

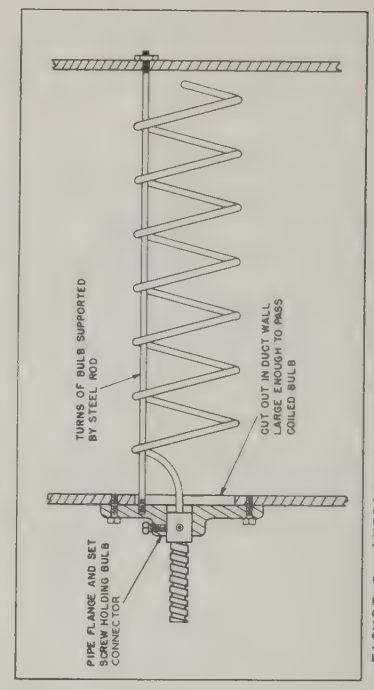

TURNS OF BULB SUPPORTED BY STEEL ROD
CUT OUT IN DUCT WALL LARGE ENOUGH TO PASS COILED BULB
PIPE FLANGE AND SET SCREW HOLDING BULB CONNECTOR

FIGURE 8 AVERAGING TYPE BULB INSTALLED IN STACK OR DUCT

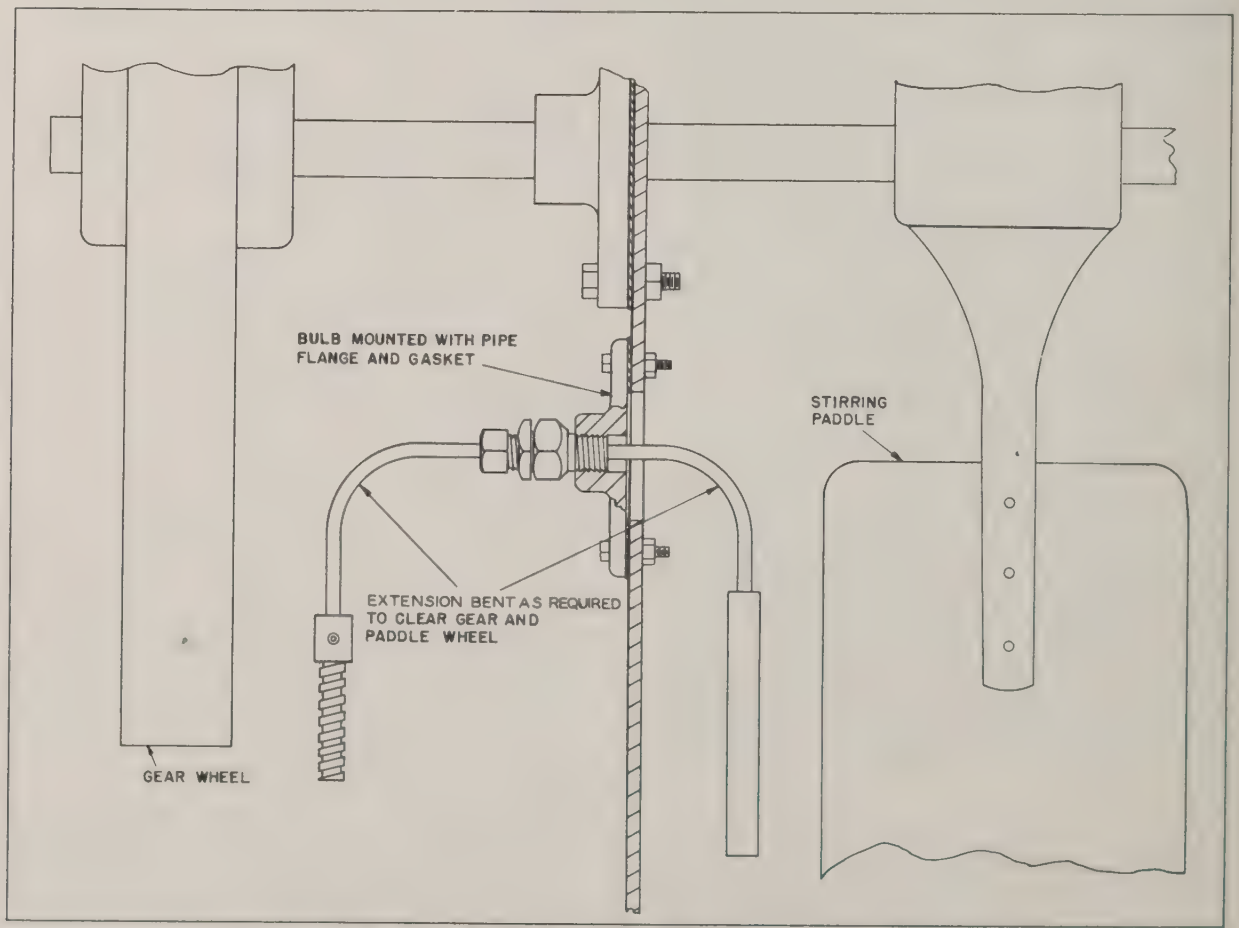

BULB MOUNTED WITH PIPE FLANGE AND GASKET
STIRRING PADDLE
EXTENSION BENT AS REQUIRED TO CLEAR GEAR AND PADDLE WHEEL
GEAR WHEEL

FIGURE 9 UNION BULB INSTALLED IN TANK SHOWING USE OF BENDABLE EXTENSION

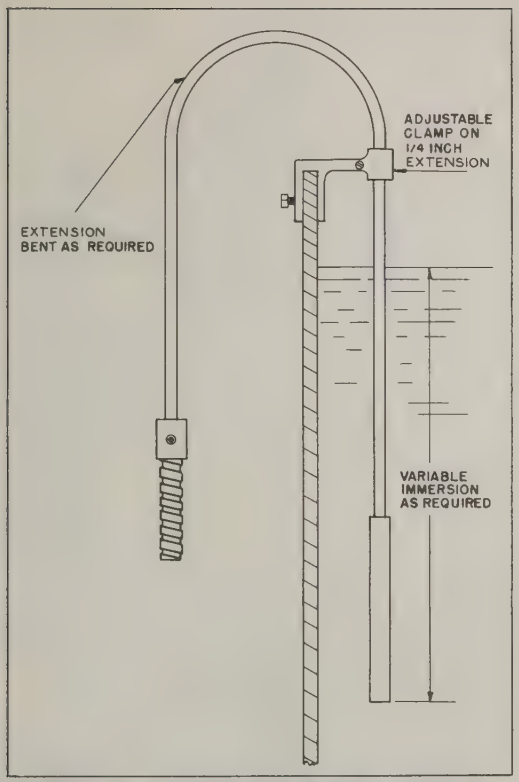


FIGURE 10 PLAIN BULB WITH LONG EXTENSION SUSPENDED BY CLAMP IN OPEN VAT OR TANK

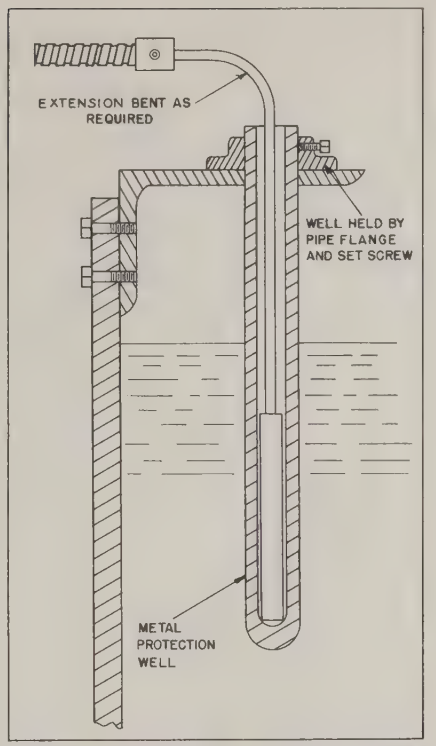


FIGURE 11 PLAIN BULB IN PROTECTION WELL FOR PROTECTION AGAINST MOLTEN METALS, CORROSIVE CHEMICALS, ETC.

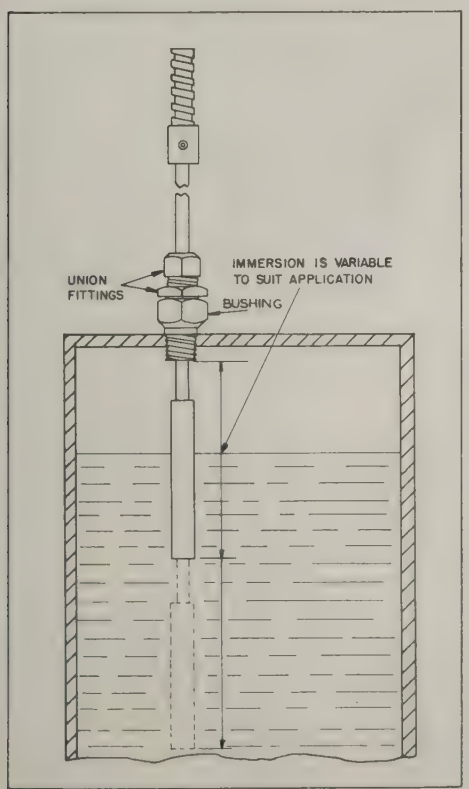


FIGURE 12 UNION BULB INSTALLED IN TANK SHOWING VARIABLE IMMERSION FEATURE

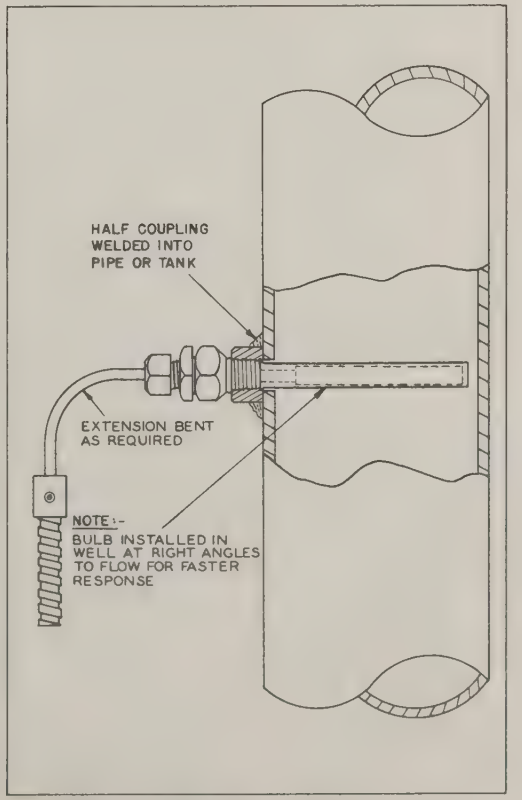

HALF COUPLING WELDED INTO PIPE OR TANK
EXTENSION BENT AS REQUIRED
NOTE:-
BULB INSTALLED IN WELL AT RIGHT ANGLES TO FLOW FOR FASTER RESPONSE

FIGURE 13 WELL BULB INSTALLED IN PIPE

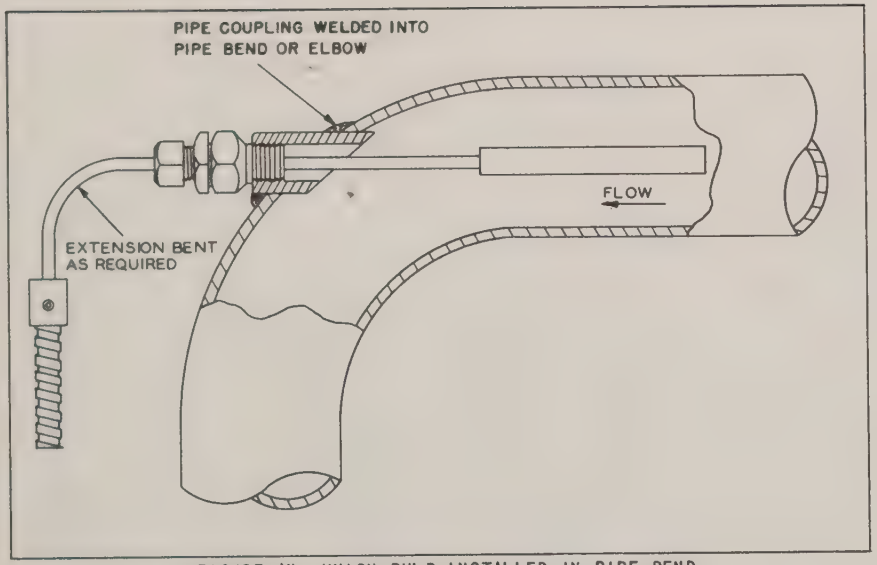


FIGURE 14 UNION BULB INSTALLED IN PIPE BEND

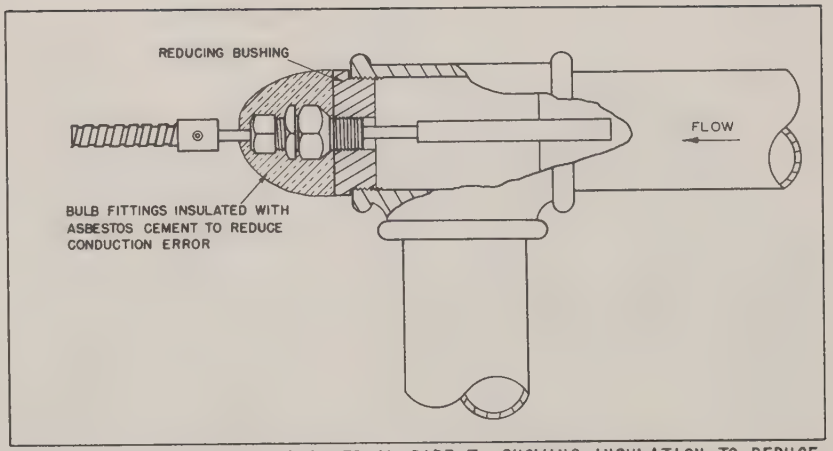


FIGURE 15 UNION BULB INSTALLED IN PIPE T, SHOWING INSULATION TO REDUCE CONDUCTION ERRORS

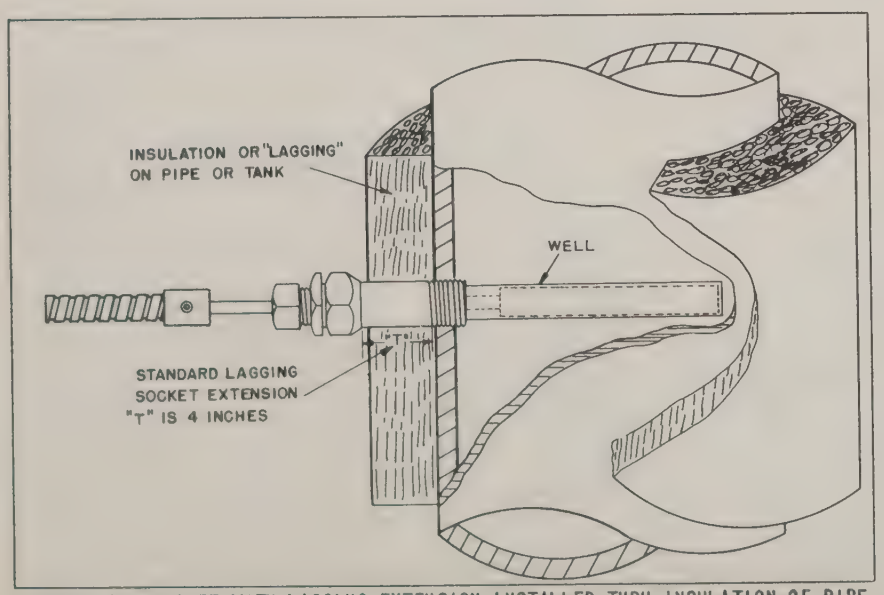


FIGURE 16 SOCKET WITH LAGGING EXTENSION INSTALLED THRU INSULATION OF PIPE

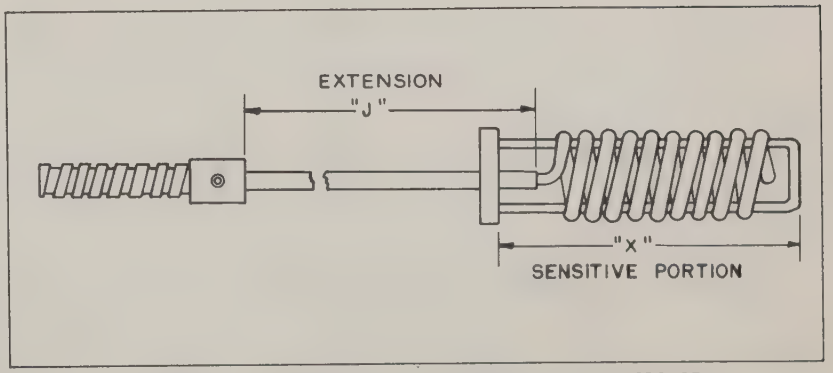


FIGURE 17 HIGH SENSITIVITY BULB FOR FAST RESPONSE

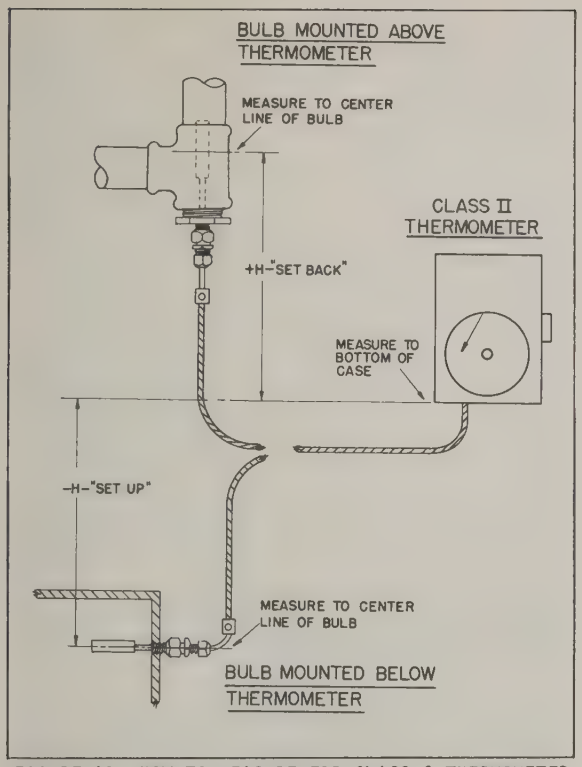

BULB MOUNTED ABOVE THERMOMETER
MEASURE TO CENTER LINE OF BULB
CLASS II THERMOMETER
+H-"SET BACK"
MEASURE TO BOTTOM OF CASE
-H-"SET UP"
MEASURE TO CENTER LINE OF BULB
BULB MOUNTED BELOW THERMOMETER

FIGURE 18 HOW TO MEASURE FOR CLASS 2 THERMOMETER BULB LEVEL CORRECTION

in bulb and case level is always measured from the center line of the bulb to the bottom of the case (see Figure 18). If possible, always order Class 2 thermometers with the bulb elevation specified so that level correction can be made in the factory.

How to Make Level Corrections in the Field. If it is necessary to make or change level corrections in the field, proceed as follows:

1. Comparison with a Test Thermometer. When the thermometer has been installed, place the thermometer bulb and an accurate test thermometer in a test bath located at the same level as that at which the bulb will be mounted. On instruments with non linear charts, turn point adjuster (10) until pen or pointer agrees with the test thermometer. On instruments with linear charts turn adjustment on temperature element until pen or pointer agrees with test thermometer. This method can also be used in laboratory calibration if the thermometer case is placed above or below the bulb during regular calibration procedure (see paragraph A, page 12, for calibration details).

2. Setting Pen by Correction Factor. If the above method is impractical, level correction can be made at any time while thermometer is installed or during calibration from data of Figures 19 and 20. These data apply only to instruments with non linear charts or scales. Elevation correction tables for instruments with linear charts may be had by writing to The Bristol Company, Waterbury, Connecticut. When writing, please specify model, serial and chart number of the instrument for which this information is desired.

For non linear charts proceed as follows:

Carefully measure difference in level between center line of bulb location and bottom of thermometer case (see Figure 18).

Select correction factor from proper column of Figure 19 or 20 corresponding to chart or scale range of thermometer concerned. Note that listed factors are for 10 feet difference in elevation.

Pen correction can now be calculated, using the following equation:

$$\text{Pen Correction (in inches)} = \frac{\text{Bulb Elevation (in feet)}}{10} \times \text{Factor from Figure 19 or 20}$$

Note: Pen correction will be plus if bulb is mounted below case. Pen correction will be minus if bulb is mounted above case.

Bring thermometer reading to any convenient steady value.

Using a finely graduated foot rule, set up or set back pen the required fraction of an inch by turning point adjustment (10).

Example: Bulb elevation 18 feet above bottom of case, chart number 22004, range 50 to 200°F. From column "bulb mounted above case - set back" (Figure 19) obtain 0.162 inches (exact correction). To obtain pen correction for 18 feet:

$$\text{Pen correction (inches)} = \frac{18}{10} \times 0.162" = 0.291" \text{ (approx. } \frac{19}{64}")$$

While thermometer is steady at any convenient temperature, say room temperature of 75°F, measure $\frac{19}{64}$" down range from 75° with an accurate steel rule. Turn

point adjuster (10) until pen reading has been set back by this $\frac{19}{64}$" amount.

G. Installation of Certain Special Bulbs

1. Atmospheric Temperatures. Thermometers for measuring weather temperatures should be equipped with extra sensitive bulbs (similar to Figure 17) in a weather house. The best location for a weather bulb is in the shade on the north side of a building (south side in southern hemisphere), at least 10 feet above ground and 2 feet out from wall, not opposite a window. For roof mounting, locate the bulb on a pole not less than 8 feet from the roof, preferably at a corner and in the full sweep of the wind from all directions. Do not mount bulb on chimneys, vents or near air shafts, sky lights, etc.

2. Averaging Bulbs. (See Figure 8.) Averaging bulbs are made with the maximum speed of response to change and due to their large dimensions can measure average temperature over a large area rather than at a point.

Averaging bulbs are, for convenience, shipped in a compact coil. **Do not pull out this coil,** but unwind it turn by turn as you would unwind wire from a spool. This will avoid twisting the bulb tubing, which might crack it. The bulb may be completely straightened out and mounted in oven, room or other process by clips or staples as with any other tubing. The bulb may be used partially coiled and supported by a rod as in Figure 8.

Caution: Never cut, break or flatten any part of averaging bulb tubing. Minimum radius of bend is 1 inch.

3. Electroplating Baths and Tanks. No part of bulb or tubing can touch any electrically conductive (metal) part of the tank or electrodes. All parts of the thermometer case and tubing must be electrically insulated from ground.

We recommend that bulb be installed on a wooden support in the tank and located between anodes and wall of tank.

Caution: Bulb or tubing must not be installed in a direct line between anode and cathode.

The thermometer case and tubing can be insulated by mounting on a wooden panel and supports.

Conduits and air control piping (if any) connected to the case must be insulated with plastic bushings.

PART III OPERATION

Filled system thermometers begin to operate as soon as the system is filled in the factory and operate continuously thereafter. For this reason no operating instructions are necessary for the thermometer system. Operation of the recording and controlling system (if any) is covered in separate instructions.

PART IV SERVICE

A. Checking and Calibrating

1. Testing for Friction. Be sure to eliminate all friction before attempting to recalibrate any thermometer. Under bad conditions of high humidity, corrosive fumes, gum forming vapors, dust laden air, etc., a possible reason for loss of calibration is corroded or dirty bearings in the thermometer system.

a. Overall test for Friction. This test should always be made before checking or calibrating.

Immerse bulb in test bath and allow pen or pointer to come to a final reading undisturbed. While watching pen or pointer closely, gently tap instrument case with a fist. If pen or pointer jumps to a new position, there must be friction somewhere.

b. Test for Element Shaft Friction. With fingers, gently move split hub (20) in and out. There should be a small amount of end play and the bearing should slide very freely on the shaft. If the bearing does not slide freely on the shaft take the bearing apart without disturbing length of lever (28) or adjustments (11), (25) or (26). To take bearing apart, loosen split hub setscrew (19), slip hub

off hollow bearing sleeve, remove 2 element mounting screws (27) and slip element together with hollow bearing off shaft. Clean bearing and shaft as per paragraph C, page 18.

In controlling thermometers check also for friction in all control links, levers, bearings, vanes, etc., which are moved by the thermometer element.

c. Pen Pressure. Considerable friction can result if the pen point bears too heavily on the chart. With fingers, bend pen arm until pen touches chart with just enough pressure to trace properly.

2. Cautions for Calibration or Checking.

Be sure thermometer case is exactly level.

Use a test thermometer with a range close to that of the thermometer being tested.

Use a recently tested test thermometer with an accuracy of 1% or better.

With recorders, make readings only from actual pen tracings quickly obtained by loosening the chart hub and turning chart slightly by hand.

3. Checking and Calibrating Procedure. Thermometers may be checked while installed or may be removed to the shop or instrument laboratory. It is best to calibrate while installed for the following reasons:

a. Saves time and handling of easily damaged tubing.

b. Automatically corrects for existing ambient temperatures along the tubing and at the case.

c. Automatically corrects Class 2 thermometers for difference in bulb and case levels.

There are two methods of checking the accuracy of filled system thermometers:

1st. Point Adjustment (also called zero adjustment). Thermometer is checked and adjusted at one point of its range only, which assures that it coincides with the standard thermometer at one temperature only.

2nd. Span Adjustment (also called range, scale length, etc., adjustment). Thermometer is checked and adjusted at two points or more of its range, which assures that it coincides with the standard thermometer at all temperatures thruout its range. This adjustment changes the span thru which the pen travels for a given change in temperature.

Step 1. Point Check and Calibration. Remove bulb from application. Remove socket or well (if any) from bulb. Run thermometer up and down scale 3 or 4 times before checking readings, especially if system has been out of service for some time, by immersing bulb alternately in cold and hot test baths.

Place an armored, glass-stem test thermometer alongside bulb so that the two bulbs are as close together as possible and then tie them together with string.

Immerse bulb and test thermometer in hot test bath. Be sure the entire sensitive portion and no more is covered.

Note: If bulb will be used with a portion of its extension (J), or a portion of its capillary tubing immersed in the measured medium, that same portion should be covered by the test bath. This procedure will correct for immersion errors. Note that glass stem test thermometers are calibrated in two ways, one for total immersion and the other for partial immersion, in which case they will have an immersion mark etched into the glass stem. Be sure that test thermometers are correctly immersed according to their calibration.

Stir test bath vigorously with a paddle for at least 3 minutes each time before taking readings. Never stir test bath with bulb itself. If possible, read test thermometer without removing it from the test bath and while continually stirring.

Quickly compare chart or scale reading with that of the test thermometer. If error is negligible and only a point check is desired, the checking procedure can end here.

If error is considerable, proceed as follows:

Turn point adjusting screw (10) until pen actually records the same temperature as the best thermometer. Recheck readings carefully. This completes the point calibration. Thermometer now coincides with test thermometer at this single point.

FIGURE 19. Correction Factors for Difference in Level between Bulb and Case. Applies only to Class 2 Recording Systems using non-linear charts. Note: Corrections listed are for a 10 foot difference. Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Chart Number	Chart Size in Inches	Temperature Range	Pen Corrections in Inches (for 10 ft.)			
			Bulb Mounted Above Case "Set Back"		Bulb Mounted Below Case "Set Up"	
			Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
		FAHRENHEIT RANGES				
22007	12"	20-90	.2205	7/32	.2695	17/64
682	12"	23-95	.3465	11/32	.4235	27/64
28000	8"	0-100	.1131	7/64	.1309	1/8
3902	12"	60-110	.333	21/64	.407	13/32
633	8"	30-130	.1178	1/8	.1363	9/64
666	8"	30-130	.1178	1/8	.1363	9/64
1968	12"	60-140	.1692	11/64	.2067	13/64
660	8"	30-150	.0835	5/64	.0967	3/32
1934	12	30-165	.099	3/32	.121	1/8
22009	12"	30-165	.1143	7/64	.1397	9/64
618	12"	30-175	.0846	5/64	.1035	7/64
644	12"	30-175	.0846	5/64	.1035	7/64
1919	12"	30-175	.0846	5/64	.1035	7/64
676	12"	80-175	.1018	3/32	.1242	1/8
1922	12"	80-175	.1018	3/32	.1242	1/8
3801	12"	80-175	.1018	3/32	.1242	1/8
22012	12"	30-180	.099	3/32	.121	1/8
28008	8"	90-180	.0788	5/64	.0912	3/32
22001	12"	100-180	.1225	1/8	.1496	5/32
22008	12"	30-200	.1575	5/32	.1925	6/32
1944	8"	30-200	.1623	5/32	.188	6/32
22004	12"	50-200	.162	5/32	.198	13/64
22013	12"	50-200	.162	5/32	.198	13/64
22017	12"	80-200	.0792	5/64	.096	3/32
1917	8"	90-200	.102	7/64	.118	1/8
685	8"	100-200	.1095	7/64	.1268	1/8
657	12"	30-212	.1117	7/64	.1364	9/64
1932	12"	30-212	.1117	7/64	.1364	9/64
22015	12"	80-220	.0585	1/16	.0715	5/64
1913	8"	120-220	.863	5/64	.100	3/32
1920	8"	120-220	.0863	5/64	.100	3/32
637	8"	30-230	.0613	1/16	.071	5/64
661	8"	30-230	.0613	1/16	.071	5/64
1909	8"	30-230	.0613	1/16	.071	5/64
629	12"	30-230	.0917	3/32	.112	7/64
1904	12"	30-230	.0917	3/32	.112	7/64
1949	12"	30-230	.0917	3/32	.112	7/64
1975	12"	30-230	.0917	3/32	.112	7/64
22003	12"	50-230	.1062	7/64	.1298	1/8
1953	12"	70-250	.0747	5/64	.0914	3/32
1962	12"	70-250	.0747	5/64	.0914	3/32
3903	12"	70-250	.0747	5/64	.0914	3/32
1959	8"	80-250	.0492	3/64	.0569	1/16
.662	8"	30-270	.0882	3/32	.1020	7/64
.696	12"	30-270	.1323	1/16	.1618	5/32
1911	12"	30-270	.1323	1/8	.1618	5/32
634	8"	30-300	.0556	3/64	.0645	1/16
663	8"	30-300	.0556	3/64	.0645	1/16
686	8"	30-300	.0556	3/64	.0645	1/16
1946	12"	30-300	.0847	5/64	.1035	7/64
22010	12"	30-300	.055	3/64	.0671	1/16
22011	12"	30-300	.055	3/64	.0671	1/16
22008	12"	30-300	.055	3/64	.0671	1/16
22009	8"	100-300	.0370	1/32	.0408	3/64
28001	8"	200-300	.0516	3/64	.0569	1/16
1921	12"	200-300	.1020	7/64	.1242	1/8
28003	8"	220-310	.0486	3/64	.0537	3/64
1963	12"	140-320	.0675	1/16	.0825	5/64
1916	8"	200-320	.050	3/64	.058	1/16
1925	8"	200-320	.050	3/64	.058	1/16
664	8"	30-330	.0406	3/64	.0452	3/64
1991	8"	30-330	.0408	3/64	.0452	3/64

678	12"	30-330	.0576	1/16	.0705	5/64
1929	12"	30-330	.0576	1/16	.0705	5/64
1942	12"	30-330	.0576	1/16	.0705	5/64
1957	12"	150-340	.0505	3/64	.0616	1/16
675	8"	30-350	.0287	1/32	.0332	1/32
1951	8"	30-350	.0287	1/32	.0332	1/32
1945	12"	30-350	.0432	3/64	.0528	3/64
28002	8"	200-350	.0418	3/64	.0484	3/64
22019	12"	200-350	.0576	1/16	.0705	5/64
1918	12"	100-360	.0477	3/64	.0584	1/16
1988	12"	100-360	.0477	3/64	.0584	1/16
1956	12"	225-375	.036	1/32	.044	3/64
1914	8"	30-400	.0147	1/64	.0172	1/64
1996	8"	30-400	.0147	1/64	.0172	1/64
1912	12"	30-400	.0252	1/32	.0308	1/32
636	8"	30-415	.013	1/64	.015	1/64
28005	8"	250-420	.1320	1/8	.1525	5/32
22025	12"	200-450	.1378	9/64	.1684	11/64
28004	8"	250-450	.102	7/64	.118	1/8
671	8"	30-500	.0492	3/64	.057	1/16
687	12"	30-500	.0747	5/64	.0913	3/32
1901	12"	30-500	.0747	5/64	.0913	3/32
1940	8"	100-550	.034	1/32	.0387	1/32
22020	12"	200-550	.0585	1/16	.0715	5/64
22022	12"	100-600	.0388	1/32	.0473	3/64
			REAUMUR RANGES			
692	8"	0-63°R	.0557	1/16	.0644	1/16
631	12"	0-63	.0837	5/64	.1025	7/64
635	12"	0-63	.0837	5/64	.1025	7/64
22005	12"	20-70	.090	3/32	.110	7/64
615	12"	0-88	.0837	5/64	.1025	7/64
624	12"	0-88	.0837	5/64	.1025	7/64
22014	12"	20-105	.0712	5/64	.087	3/32
			CENTIGRADE RANGES			
643	8"	0-50°C	.137	9/64	.159	5/32
1905	8"	0-55°C	.114	7/64	.132	1/8
1979	12"	25-65	.162	5/32	.198	13/64
1903	8"	20-71	.0835	5/64	.0967	3/32
28006	8"	0-75	.077	5/64	.089	3/32
1908	8"	0-80	.0553	1/16	.0643	1/16
1955	12"	0-80	.0837	5/64	.1025	7/64
1986	12"	0-80	.0837	5/64	.1025	7/64
22028	12"	30-80	.118	1/8	.144	9/64
632	8"	0-100	.076	5/64	.088	3/32
683	8"	0-100	.076	5/64	.088	3/32
665	12"	0-100	.115	7/64	.141	9/64
695	12"	0-100	.115	7/64	.141	9/64
22000	12"	60-100	.0945	3/32	.1155	7/64
1994	12"	0-104	.0468	3/64	.0572	1/16
1999	12"	0-104	.0468	3/64	.0572	1/16
1906	8"	0-110	.0603	1/16	.0697	1/16
1907	8"	0-110	.0603	1/16	.0697	1/16
1936	12"	0-110	.0918	3/32	.112	7/64
28007	8"	0-110	.0324	1/32	.0376	1/32
22026	12"	40-110	.123	1/8	.1485	9/64
1902	12"	0-130	.142	9/64	.174	11/64
674	12"	0-130	.142	9/64	.174	11/64
22016	12"	0-130	.0675	1/16	.0825	5/64
22027	12"	0-130	.0675	1/16	.0825	5/64
1939	8"	0-132	.0388	1/32	.045	3/64
1933	12"	25-145	.0945	3/32	.1155	7/64
630	8"	0-150	.0547	3/64	.0633	1/16
1971	8"	0-150	.0547	3/64	.0633	1/16
22024	12"	40-150	.0513	3/64	.0627	1/16
22018	12"	40-155	.0468	3/64	.0572	1/16
1943	12"	60-160	.0675	1/16	.0825	5/64
679	12"	0-165	.0576	1/16	.0705	5/64
1923	12"	0-165	.0576	1/16	.0705	5/64
1973	12"	30-165	.0576	1/16	.0705	5/64
1964	8"	50-165	.0388	1/32	.045	3/64
1948	8"	50-175	.0315	1/32	.0365	1/32
1937	12"	50-175	.0468	3/64	.0572	1/16
641	8"	0-185	.026	1/32	.030	1/32
1927	12"	50-195	.0306	1/32	.0374	1/32
677	8"	0-200	.0176	1/64	.0202	1/64
1960	8"	0-200	.0176	1/64	.0202	1/64
1952	12"	50-250	.0848	1/64	.1045	1/64

FIGURE 19 - CONTINUED -

Figure 20. 8" Segment Scale Indicating Class 2 Thermometer Correction Factors for Difference in Level Between Bulb & Case.
Note: Corrections listed are for a **10 feet difference.** Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Scale Number	Temperature Range Degrees	Pointer Corrections in inches (for 10 feet)			
		Bulb Mounted above case "set back"		Bulb Mounted below case "set up"	
		Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
5300	50-130F	.276	9/32	.320	21/64
5301	60-160F	.167	11/64	.193	3/16
5302	80-190F	.109	7/64	.127	1/8
5303	100-230F	.067	1/16	.077	5/64
5304	100-270F	.086	3/32	.100	3/32
5305	150-320F	.054	3/64	.061	1/16
5306	250-350F	.081	5/64	.094	3/32
5307	200-370F	.054	3/64	.061	1/16
5308	240-420F	.253	1/4	.293	19/64
5309	300-470F	.148	9/64	.172	11/64
5310	300-500F	.115	7/64	.133	9/64
5311	40-110C	.067	1/16	.077	5/64

If it is desired to have the thermometer read correctly thru its whole range, proceed as below.

Mechanical Alignment. This step should be necessary only if the link length adjustment (11) or adjustments of lever (9) or hub (20) have been disturbed. Mechanical alignment adjustment places all links and levers in correct geometrical relation so as to minimize angularity errors.

Place bulb in test bath at a temperature to hold pen or pointer at about mid chart or scale.

Loosen hub screw (19) and two link screws (11). Center the point adjuster (10). While manually holding pen or pointer at mid scale, adjust length of link (13) so that imaginary line "A-A" connecting the center line of element shaft and link bearing (24) is parallel to lever (9). While holding this parallelism tighten screws (11) and hub screw (19) firmly.

Step 2. Span Check and Calibration. It will be necessary to remove the chart plate and chart to reach the span adjustment.

Screwing span adjustment nut (26) back and forth changes the effective length of threaded lever (28). Increasing the lever length increases the span thru which the pen travels for a given temperature change. Decreasing the lever length decreases the span thru which the pen travels for a given temperature change.

Proceed as follows: Carefully perform point calibration as in Step 1 above. Immerse bulb and test thermometer in a cold test bath. Stir and compare readings as directed above.

If span is too long (thermometer reads low), loosen span lock screw (25) and reduce span by turning span adjustment nut (26) slightly toward shaft end of threaded lever. If span is too short (thermometer reads high), turn nut toward outer end of threaded lever.

Recheck in a hot bath and adjust with point adjustment on pen arm. Recheck in cold bath and adjust span if necessary.

Alternately repeat point and span adjustments until thermometer is exactly correct in both hot and cold baths. Retighten span lock screw (25) firmly. Thermometer should then coincide with test thermometer at all values of its range.

Note: On controlling thermometers with either electric or air control, the controller set-point indexes must always be adjusted after pen or pointer adjustment is changed. For details of calibration of set-point indexes, see separate instructions furnished covering the controlling system.

To avoid inconvenience of repeated removal and replacement of the recording chart and chart plate between each test reading, prepare a cut away chart from thermometer being calibrated as per Fig-

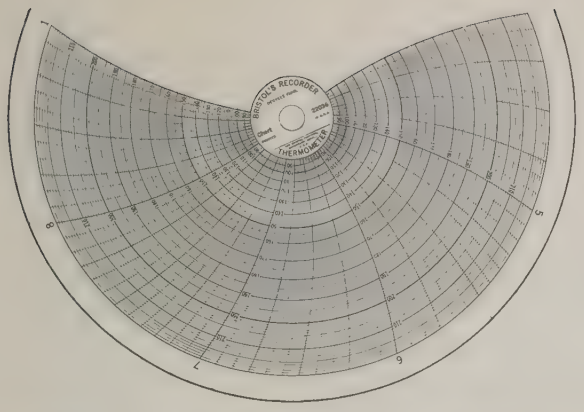


FIGURE 21 CUTAWAY CHART FOR USE IN CALIBRATION

ure 21. Paste cut away chart on stiff cardboard for support. During calibration remove chart plate and use this cut away chart held by chart hub.

4. Calibrating Temperatures. If only a point check and calibration is made, it is obviously wise to select a test bath temperature close to the working range of the thermometer.

If a span calibration is to be made, select "cold" and "hot" test bath temperatures at approximately 20% and 80% of the full range of the thermometer being tested.

B. Replaceable Thermometer Systems

All Bristol filled type thermometer systems are so made that entire temperature systems can be exchanged or replaced in the field without disturbing its calibration. New factory calibrated thermometer systems can be ordered from Bristol at any time. Factory made replacement systems are calibrated and tested in a standard recording thermometer, then removed without disturbing the calibration. The systems are then packed and shipped ready for easy installation in the field.

1. Changing Ranges. An important feature of Bristol thermometers is that thermometer systems of any range or any class can be interchanged without drilling or extra parts. Another feature is that a thermometer can be changed to a gauge by replacing the thermometer system with a pressure gauge system.

2. Standby Thermometer Systems. Users having a quantity of Bristol thermometers will find it advantageous to stock one or two calibrated thermometer systems of each range used, for quick replacement in case of damage to or failure of a system. Standby thermometer systems should be ordered with tubing long enough for any existing installation and equipped with a Bristol universal bulb for ready adaptation to almost any bulb installation.

3. How to Remove Thermometer Systems. Systems to be exchanged, repaired or replaced should be removed as follows:

Remove bulb from the process. Dismount tubing, coil and tie it, being careful not to cut, twist or kink it.

Remove case fitting (15), which holds tubing, from the split connecting plate. **Do not** allow weight of the coil of tubing to hang by the delicate capillary (17).

Disconnect lower end of link (13) from span adjuster (25) by lifting and swinging aside tab (24). **Do not** loosen screw (25) or disconnect top bearing of link (13) from lever (9).

Note: There are several bearing holes in pen shaft lever (9). All holes but one are painted black. Your thermometer was factory calibrated using the unpainted hole. **Use no other.**

Dismount bracket (18) by removing 2 screws (23) which hold it to the back of the case.

Remove entire thermometer system as a unit including element, element mounting, span adjuster, tubing, case connection fitting and bulb.

4. How to Install Replacement Thermometer Systems. Carefully unpack replacement system. **Do not** disturb any of its adjustments.

Install element and tubing in the reverse order to instructions given in paragraph 3 above.

When completely installed except for the bulb, perform a point check at working temperature as instructed in Step 1 on page 13. If span adjuster and connecting link have not been disturbed, the thermometer should be in perfect calibration.

Note: When thermometer systems from 8" and 12" size instruments are interchanged, a complete recalibration is required due to the difference in pen arm radii and pen weight.

5. How to Order Replacement Thermometer Systems. Order replacements from the nearest Bristol Branch Office, giving the serial number and chart number of your thermometer as listed on the name plate inside the door. If ordering a system not exactly like your existing one, be sure to specify the new range and new chart number desired, or new bulb number, union or socket thread size and length of tubing. If changing range, don't forget to order a stock of the charts.

C. Lubrication and Cleaning

Never lubricate any bearing in a thermometer measuring system. If bearings become gummy or dirty, clean with a solvent such as carbon tetrachloride applied with a small soft brush. If bearings become badly corroded, polish gently with crocus cloth. **Never** Use a file or emery.

For lubrication of chart drives see recording system instructions.

D. Repairs, Correspondence and Shipping

Send all correspondence and orders to the nearest Bristol Branch Office.

Send all parts and thermometers for repair or exchange only to Branch or Main Factories, not to Branch Offices.

Be sure to state model and serial numbers in all orders, correspondence and shipments.

Identify your shipments fully, including exact return address, your order number, etc.

See last page of instruction book for list of addresses of Bristol Field Organization.

The Bristol Company
Waterbury 20, Conn.

Printed in U.S.A.

THE BRISTOL COMPANY
Waterbury 20, Connecticut., U.S.A.

PARTS LIST
October 1958

T8005

CONVERTIBLE THERMOMETER BULB FITTINGS

(USED ON SERIES 500 INSTRUMENTS)

COMPLETE UNIONS AND WELLS

HOW TO ORDER UNIONS & WELLS

1st. Select specification of bulb you have (as listed on your thermometer name plate) from Column I.
2nd. Follow to the right along horizontal line column II listing complete union or column III listing complete socket.
3rd. Order complete union by part no. as listed in Column II.
4th. Order complete well by part no. and length "U" as listed in Column III.

Notes: 1. The bulb itself cannot be purchased separately, but only as part of a complete thermometer system.
2. Union and well parts must be large enough to slip over sensitive portion "X" of bulb. Therefore, always go from bulb specification number horizontally or down in table to union or well number.
3. Class I sensitive bulb length "X" varies with range so cannot be listed. However "X" length will be listed as last number of specification on your thermometer's nameplate.
4. Minimum well length "U" should be ordered long enough to accommodate sensitive portion "X" plus "J" immersion of 3 inches, if possible, and never less than 1 inch, to minimize conductivity errors. See "Thermometer Measuring System" instructions for explanation.

COLUMN I Plain Bulb Specifications					COLUMN II Unions Complete			COLUMN III Wells Complete			
BULB SPECIFICATION	MATERIAL	Y	J	X	MATERIAL	ST'D PIPE THREAD	PART NO. COMPLETE UNION	MATERIAL	ST'D PIPE THREAD	PART NO. COMPLETE WELL	WELL LENGTH "U" IN INCHES
CLASS I THERMOMETER BULBS											
1013-10-( )	Copper	3/8"	10	(See Note 3 above)	Brass	1/2"	82920	bronze	1/2"	84424	Minimum Well length "U" is determined by sensitive length "X" plus minimum immersion of extension "J"(see note 4) Standard Class I Well lengths are: $2\frac{1}{2}$"-$3\frac{1}{2}$"-$5\frac{1}{2}$"-$7\frac{1}{2}$" 9"-12"-18"-24"-30"
1013-30-( )	Copper	3/8"	30		brass	1/2"	82920	bronze	1/2"	84424	
1013-60-( )	Copper	3/8"	60		brass	1/2"	82920	bronze	1/2"	84424	
1023-10-( )	Stain. S.	3/8"	10		Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	
1023-30-( )	Stain. S.	3/8"	30		Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	
1023-60-( )	Stain. S.	3/8"	60		Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	
1015-10-( )	Copper	5/8"	10		brass	3/4"	82923	bronze	3/4"	84426	
1015-30-( )	Copper	5/8"	30		brass	3/4"	82923	bronze	3/4"	84426	
1015-60-( )	Copper	5/8"	60		brass	3/4"	82923	bronze	3/4"	84426	
1025-10-( )	Stain. S.	5/8"	10		Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	
1025-30-( )	Stain. S.	5/8"	30		Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	
1025-60-( )	Stain. S.	5/8"	60		Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	
1034-30-( )	LEAD PROTEC-	1/2"	30		brass or	3/4"	82923				
1034-60-( )	TED COPPER	1/2"	60		Stain. St.	3/4"	84550				
1116-10-( )	Coil	3/4"	10		brass	1"	84551				
1116-30-( )	Bulbs	3/4"	30		brass	1"	84551				
1116-60-( )	Copper	3/4"	60		brass	1"	84551				
1126-10-( )	Coil	3/4"	10		Stain. St.	1"	84552				
1126-30-( )	Bulbs	3/4"	30		Stain. St.	1"	84552				
1126-60-( )	St. St.	3/4"	60		Stain. St.	1"	84552				
CLASS 2A THERMOMETER BULBS											
2013-10-040	Copper	3/8"	10	4"	brass	1/2"	82920	bronze	1/2"	84424	$5\frac{1}{2}$-$7\frac{1}{2}$
2013-30-040	Copper	3/8"	30	4"	brass	1/2"	82920	bronze	1/2"	84424	$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24
2013-60-040	Copper	3/8"	60	4"	brass	1/2"	82920	bronze	1/2"	84424	$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24-30
2023-10-040	Stain. S.	3/8"	10	4"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	$5\frac{1}{2}$-$7\frac{1}{2}$
2023-30-040	Stain. S.	3/8"	30	4"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24
2023-60-040	Stain. S.	3/8"	60	4"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24-30
2015-10-015	Copper	5/8"	10	1.50"	brass	3/4"	82923	bronze	3/4"	84426	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$
2015-30-015	Copper	5/8"	30	1.50"	brass	3/4"	82923	bronze	3/4"	84426	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24
2015-60-015	Copper	5/8"	60	1.50"	brass	3/4"	82923	bronze	3/4"	84426	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24-30
2025-10-015	Stain. S.	5/8"	10	1.50"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$
2025-30-015	Stain. S.	5/8"	30	1.50"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24
2025-60-015	Stain. S.	5/8"	60	1.50"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	$2\frac{1}{2}$-$3\frac{1}{2}$-$5\frac{1}{2}$-$7\frac{1}{2}$-9-12-18-24-30
2034-30-070	LEAD PROTEC-	1/2"	30	7"	Brass or	3/4"	82923				
2034-60-070	TED COPPER	1/2"	60	7"	Stain. St.	3/4"	84550				
2116-10-040	Coil	3/4"	10	4"	brass	1"	84551				
2116-30-040	Bulbs	3/4"	30	4"	brass	1"	84551				
2116-60-040	Copper	3/4"	60	4"	brass	1"	84551				
2126-10-040	Coil	3/4"	10	4"	Stain. St.	1"	84552				
2126-30-040	Bulbs	3/4"	30	4"	Stain. St.	1"	84552				
2126-60-040	St. St.	3/4"	60	4"	Stain. St.	1"	84552				

CLASS 2D THERMOMETER

BULB SPECIFICATION	MATERIAL	Y	J	X	MATERIAL	ST'D PIPE THREAD	PART NO. COMPLETE UNION	MATERIAL	ST'D PIPE THREAD	PART NO. COMPLETE UNION	WELL LENGTH "U" IN INCHES
2D013-10-075	Copper	3/8"	10	7.5"	Brass	1/2"	82920	bronze	1/2"	84424	9-12
2D013-30-075	Copper	3/8"	30	7.5"	brass	1/2"	82920	bronze	1/2"	84424	9-12-18-24-30
2D013-60-075	Copper	3/8"	60	7.5"	brass	1/2"	82920	bronze	1/2"	84424	9-12-18-24-30
2D023-10-075	Stain. St.	3/8"	10	7.5"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	9-12
2D023-30-075	Stain. St.	3/8"	30	7.5"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	9-12-18-24-30
2D023-60-075	Stain. St.	3/8"	60	7.5"	Stain. St.	1/2"	82921	Welded S. S.	1/2"	84425	9-12-18-24-30
2D015-10-030	Copper	5/8"	10	3"	brass	3/4"	82923	bronze	3/4"	84426	5½-7½
2D015-30-030	Copper	5/8"	30	3"	brass	3/4"	82923	bronze	3/4"	84426	5½-7½-9-12-18-24
2D015-60-030	Copper	5/8"	60	3"	brass	3/4"	82923	bronze	3/4"	84426	5½-7½-9-12-18-24-30
2D025-10-030	Stain. St.	5/8"	10	3"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	5½-7½
2D025-30-030	Stain. St.	5/8"	30	3"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	5½-7½-9-12-18-24
2D025-60-030	Stain. St.	5/8"	60	3"	Stain. St.	3/4"	84550	Welded S. S.	3/4"	84427	5½-7½-9-12-18-24-30
2D116-10-125	Coil	3/4"	10	12.5"	brass	1"	84551				
2D116-30-125	Bulbs	3/4"	30	12.5"	brass	1"	84551				
2D116-60-125	Copper	3/4"	60	12.5"	brass	1"	84551				
2D126-10-125	Coil	3/4"	10	12.5"	Stain. St.	1"	84552				
2D126-30-125	Bulbs	3/4"	30	12.5"	Stain. St.	1"	84552				
2D126-60-125	Stain. St.	3/4"	60	12.5"	Stain. St.	1"	84552				

CLASS 3 THERMOMETER BULBS

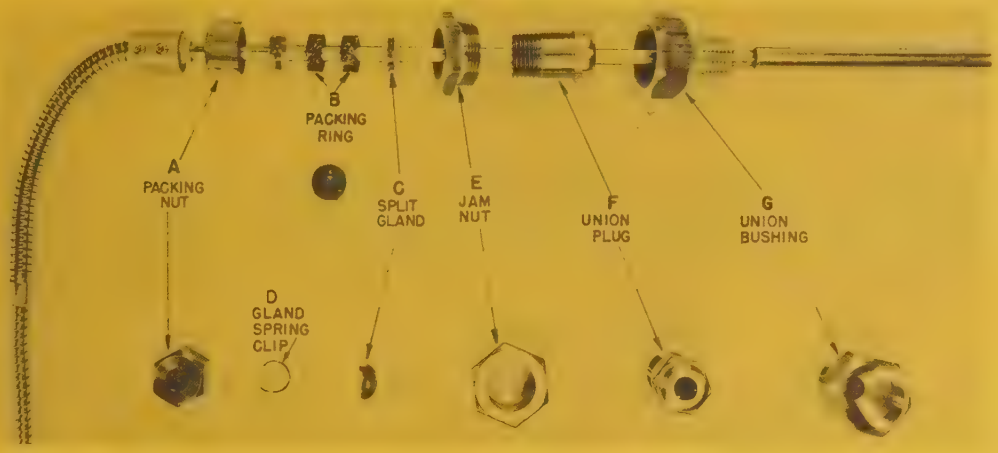
3016-10-100	Copper	3/4"	10	10"	brass	1"	84551	bronze	1"	84429	10½-12
3016-30-100	Copper	3/4"	30	10"	brass	1"	84551	bronze	1"	84429	10½-12-18-24-30
3016-60-100	Copper	3/4"	60	10"	brass	1"	84551	bronze	1"	84429	10½-12-18-24-30
3026-10-100	Stain. St.	3/4"	10	10"	Stain. St.	1"	84552	Welded S. S.	1"	84430	10½-12
3026-30-100	Stain. St.	3/4"	30	10"	Stain. St.	1"	84552	Welded S. S.	1"	84430	10½-12-18-24-30
3026-60-100	Stain. St.	3/4"	60	10"	Stain. St.	1"	84552	Welded S. S.	1"	84430	10½-12-18-24-30
3018-10-050	Copper	1"	10	5"	brass	1¼"	84568	bronze	1¼"	84431	5½-7½
3018-30-050	Copper	1"	30	5"	brass	1¼"	84568	bronze	1¼"	84431	5½-7½-12-18-24
3018-60-050	Copper	1"	60	5"	brass	1¼"	84568	bronze	1¼"	84431	5½-7½-12-18-24-30
3028-10-050	Stain. St.	1"	10	5"	Stain. St.	1¼"	84569	Welded S. S.	1¼"	84432	5½-7½
3028-30-050	Stain. St.	1"	30	5"	Stain. St.	1¼"	84569	Welded S. S.	1¼"	84432	5½-7½-12-18-24
3028-60-050	Stain. St.	1"	60	5"	Stain. St.	1¼"	84569	Welded S. S.	1¼"	84432	5½-7½-12-18-24-30
3119-10-060	Copper	3/4"	10	6"	brass	1"	84551				
3119-30-060	Coil *	3/4"	30	6"	brass	1"	84551				
3119-60-060	Bulbs	3/4"	60	6"	brass	1"	84551				
3129-10-060	Stain. St.	3/4"	10	6"	Stain. St.	1"	84552				
3129-30-060	Coil *	3/4"	30	6"	Stain. St.	1"	84552				
3129-60-060	Bulbs	3/4"	60	6"	Stain. St.	1"	84552				
3038-30-110	LEAD PROTECTED COPPER	1"	30	11"	Stain. St.	1¼"	84569				
3038-60-110	LEAD PROTECTED COPPER	1"	60	11"	brass	1¼"	84568				
3216-10	COPPER WITH RAD. FINS	3/4"	10	10"							

EXTRA HEAVY LAGGING WELL FOR HIGH PRESSURE, MACHINED FROM STEEL FORGING. ALL FITTINGS ARE BRASS.

MATERIAL		PART NO.	WELL LENGTH "U"
Solid Steel	1" S.P.T.	86187	10½"
Solid Steel	1¼" S.P.T.	87926	5½"

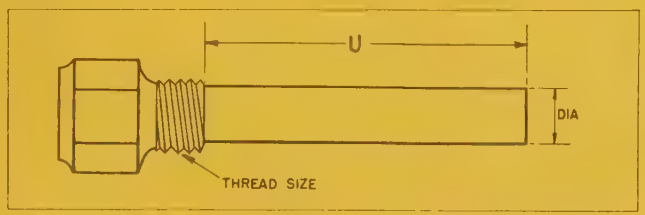
*Union cannot slip on over whole bulb coil but must be slipped over the 25 ft. of bulb tubing

UNION PARTS



FOR BULB SIZE (INCHES)	ST'D THREAD SIZE (INCHES	METAL	A PACKING NUT	B PACKING RING (2 REQUIRED)	C 1/2 SPLIT GLAND (4 REQUIRED)	D GLAND SPRING CLIP (2 REQUIRED	E JAM NUT	F UNION PLUG	G UNION BUSHING	PART NO. OF COMPLETE UNION
3/8	1/2	brass	83923	84367	84014	86839	83921	83922	83920	82920
1/2 or 5/8	3/4	brass	83929	84368	84016	86840	83927	83928	83925	82923
3/4	1	brass	83929	84368	84016	86840	83927	83928	83925	84551
1	1¼	brass	84454	84977	84975	86841	84456	84455	84457	84568
3/8	1/2	S.S.	83930	84367	84015	86839	83933	83932	83931	82921
1/2 or 5/8	3/4	S.S.	83938	84368	84017	86840	83937	83936	83935	84550
3/4	1	S.S.	83938	84368	84017	86840	83937	83936	83939	84552
1	1¼	S.S.	84458	84977	84976	86841	84565	84459	84566	84569

NOTE: All wells use exactly the same fittings as unions of the same thread size above, except that union bushing "G" is replaced by the well.



WELLS ONLY

Be sure to specify part number and length "U" in ordering wells

FOR BULB SIZE (INCHES)	STANDARD PIPE THREAD (INCHES)	METAL	WELL DIAM. D (INCHES)	PART NUMBER WELL ONLY	STANDARD "U" LENGTHS (INCHES) (SEE NOTES 2 & 4 PAGE 1 ON HOW TO ORDER)
3/8	1/2	bronze	1/2	84912	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	bronze	3/4	84910	2½-3½-5½-7½-12-18-24-30
3/4	1	bronze	7/8	84914	10½-12-18-24-30
1	1¼	bronze	1 5/32	84916	5½-7½-12-18-24-30
3/8	1/2	Stain. St.	1/2	84913	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	Stain. St.	3/4	84911	2½-3½-5½-7½-12-18-24-30
3/4	1	Stain. St.	7/8	84915	10½-12-18-24-30
1	1¼	Stain. St.	1 1/8	84917	5½-7½-12-18-24-30
3/8	3/4	Aluminum	7/8	85122	4 - 6 - 9

INSTRUCTION NO. W18202
(Issue No. 2 of 4/56)

INSTALLATION AND OPERATION
BRISTOL'S TIME PROGRAM CONTROLLER
MECHANICAL LINK TYPE

NOTE: This instruction covers only the installation and operation of the Time Program Controller. See separate instructions covering installation and service of the measuring system, cutting of cams, recording system and control system as required.

PART I GENERAL DESCRIPTION

This instrument is designed to control any measured variable, such as temperature, pressure, etc., by means of pneumatic or electronic control equipment built into the case. The set point, instead of being shifted manually as on standard controllers, is shifted continuously by a cam follower sliding on a cam cut according to the desired program.

Time program Controllers are made up in either single case, non-indicating, non-recording types or two case recording types. The two case controllers are mounted on a small panel with interconnections as required. Some of the features described in paragraph A below may be omitted to meet certain customer requirements.

A. Functions of Various Parts

1. Cam Motor. The cam motor will operate when the toggle switch on front of door is thrown to the "on" position and the snap action switch is in its running position. It will stop operating when the cam and index pointer* drop below the temperature, pressure, etc., to which the snap action switch has been set. The snap action switch is set by means of the red knob in the upper part of the case. The cam motor may be stopped at any time by turning the toggle switch to the "off" position.

2. Green Light. This light shows that the cam motor is running.

3. Red Light. This light is on whenever the cam motor is stopped.

4. Toggle Switch. This switch is used to start and stop the cam motor. When the toggle switch is thrown to the "on" position and the snap action switch is in its running position, the cam motor starts and the green light goes on. Control will then proceed as directed by the contour of the cam. When the cam follower drops towards the center of the cam at the end of the cycle, the cam motor stops, the green light goes off and the red light goes on. If there is an external siren or bell, it will start to sound and will continue to sound until toggle switch is thrown to "off". Alarm circuits are usually provided on pneumatic type program controllers. If there is no bell or siren connected to the alarm terminals, the toggle switch may be left in the "on" position as in that case only the red light will be lit.

* Index pointers are used only on two case jobs.

5. Snap Action Switch. The function of this switch is to automatically stop the cam motor at the end of the desired period. This is accomplished by cutting the cam with a sharp drop at the end of the cycle. The snap action switch can be adjusted by means of the red knob to stop the cam motor whenever the cam follower drops to any desired point.

PART II INSTALLATION

See separate instructions covering the installation of the case, control system and how to cut cams. See nameplate of instrument for proper voltage and frequency. Proper wiring diagrams are furnished for each controller.

PART III OPERATION

Turn toggle switch to the "off" position. With power turned on, red light will light but cam motor will not run. By means of key furnished, turn cam counterclockwise until cam follower is at the proper starting point.

Turn toggle switch to "on". Motor should start, green light lights and red light goes out.

As cam follower mechanically moves the set-point index in the case, control will now start and will continue until cam follower drops towards the center of the cam. The snap action switch then stops the cam motor, green light goes out and red light and alarm go on. Alarm can be stopped by throwing toggle switch to "off". If there is no external alarm signal hooked up to the controller, the toggle switch may be left in the "on" position as only the red light will be on.

The controller is started on another cycle by simply turning the cam until the green light goes on.

THE BRISTOL COMPANY
WATERBURY 20, CONNECTICUT, U.S.A.

THE BRISTOL COMPANY
Waterbury 20, Connecticut., U.S.A.

PARTS LIST
August 1962

W18203

Replaces Issue of 1/62

PARTS LIST FOR BRISTOL'S® SERIES 500 TWO-CASE ELECTRONIC FREE-VANE® PROGRAM CONTROLLER. (ONE OR TWO CAM)

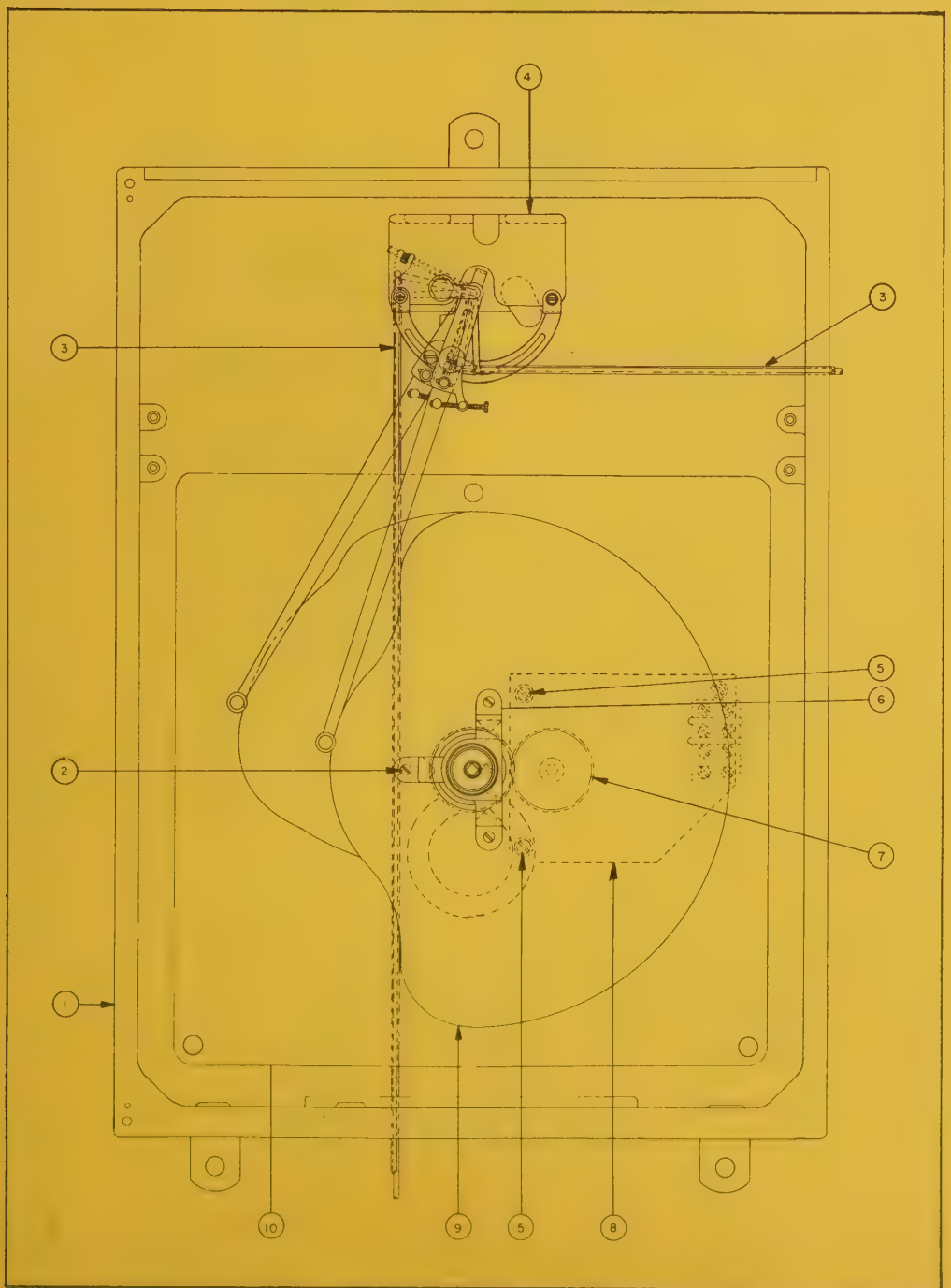


FIGURE 1. FRONT VIEW OF CAM CASE.

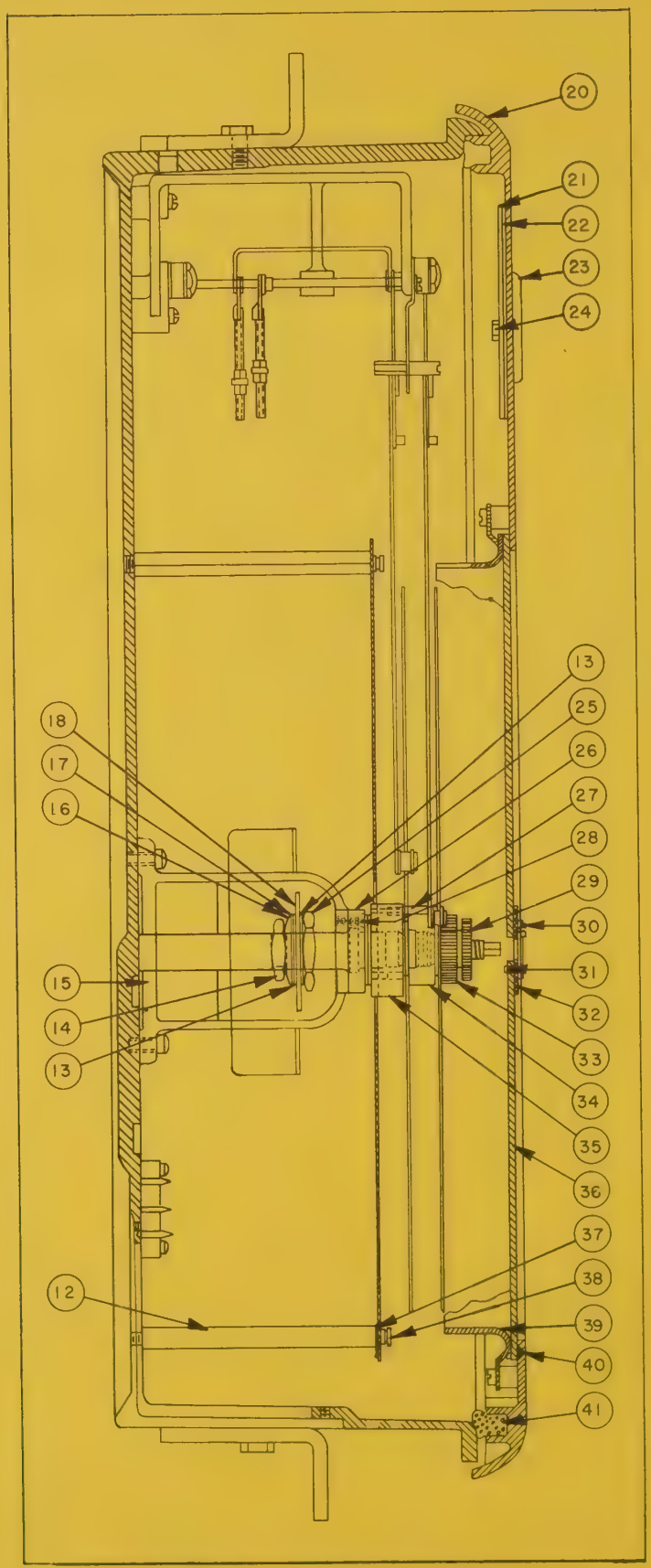


FIGURE 2. SIDE VIEW OF CAM CASE.

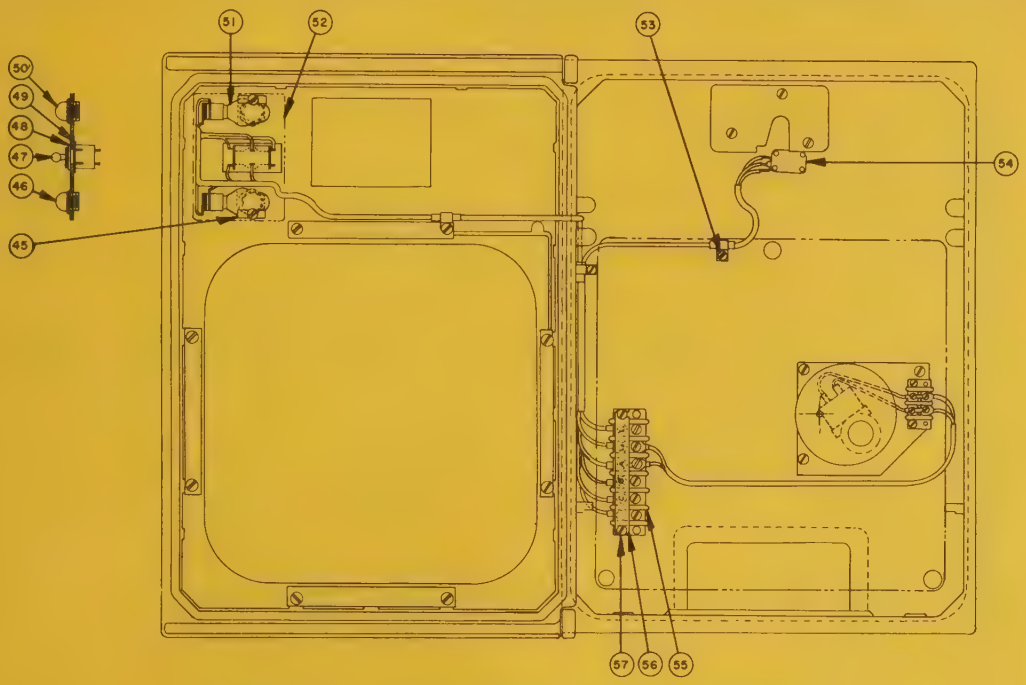


FIGURE 3. CAM CASE SHOWING STANDARD ATTACHMENTS.

ITEM	PART. NO.	DESCRIPTION
		APPLIES TO FIGURES 1, 2 & 3.
1		Case complete (specify model & serial numbers of instrument)
2	66541	#10-32 x 1/2" Fillister-head screw
3	93536	Links (used with 2-case 2-cam, 2-case 1-cam) program component of Horizontally linked program controller.
	94616	Links (used with 2-case 2-cam, 2-case 1-cam) program component of Vertically linked program controller.
4		Cam follower mountings
	B2178	Used on all 1-cam horizontally linked program controllers
	B2182	Used on all 1-cam vertically linked program controllers
	B2177	Used on all 2-cam horizontally linked program controllers
	B2179	Used on all 2-cam vertically linked program controllers
5	35882	#6-40 x 1/2" Fillister-head screw
	60125	Washer
6	94979	Counter shaft complete
7	94606	Spur gear complete
	82404	#6-40 x 3/16" Set-screw
8		Cam drive (standard) specify spindle speed, voltage, frequency and type of motor. Specify model & serial no. of instrument. Cam drive assembly with change gears, refer to page 5.
9		Cam, order as required, specify model & serial no. of instrument
10	93558	Dial plate
12	94987	Dial plate post
13	79236	Clutch facing
14	75856	1/2" - 27 Hex nut
15	94980	Casting
16	96004	Spider washer
17	79237	Washer
18	94983	Gear (78T - 48P)

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
20	A7418	Case cover complete
21	86800	Name plate cover
22	93569	Name plate
23	85155	Emblem plate
24	13775	Nut
25	93529	Hub
26	88086	Bearing housing
27	93551	Pin
28	21988	#4 - 48 Flat-head screw
29	94986	1/4" - 20 Nut
30	94621	#3 - 56 Shoulder screw
31	12613	#3 - 56 x 1/8" Flat-head screw
32	94620	Key hole
33	94625	1/2" - 27 Nut
34	93556	Spacer nut
35	93555	Spacer for cams
36	94612	Glass
37	93559	Washer
38	66625	Thumb screw
39	82642	Shield
40	84725	Gasket (under glass)
41	82608	Gasket (large groove)
45	96009	Bracket
46	77800	Socket assembly complete (red)
47	56496	Double pole, double throw switch
48	67030	Nameplate ON - OFF
49	76294	Insulation
50	77801	Socket assembly complete (green)
51	46516	Lamp bulb 120 V. } as required
	77913	Lamp bulb 240 V. }
52	96008	Shield
53	88824	#6 Self-tapping screw
54	96002	End of cycle switch
55	87238	Terminal block (6 point)
56	87629	Marking strip
57	60349	#10-32 x 7/8" Fillister-head screw
	72166	Spacer

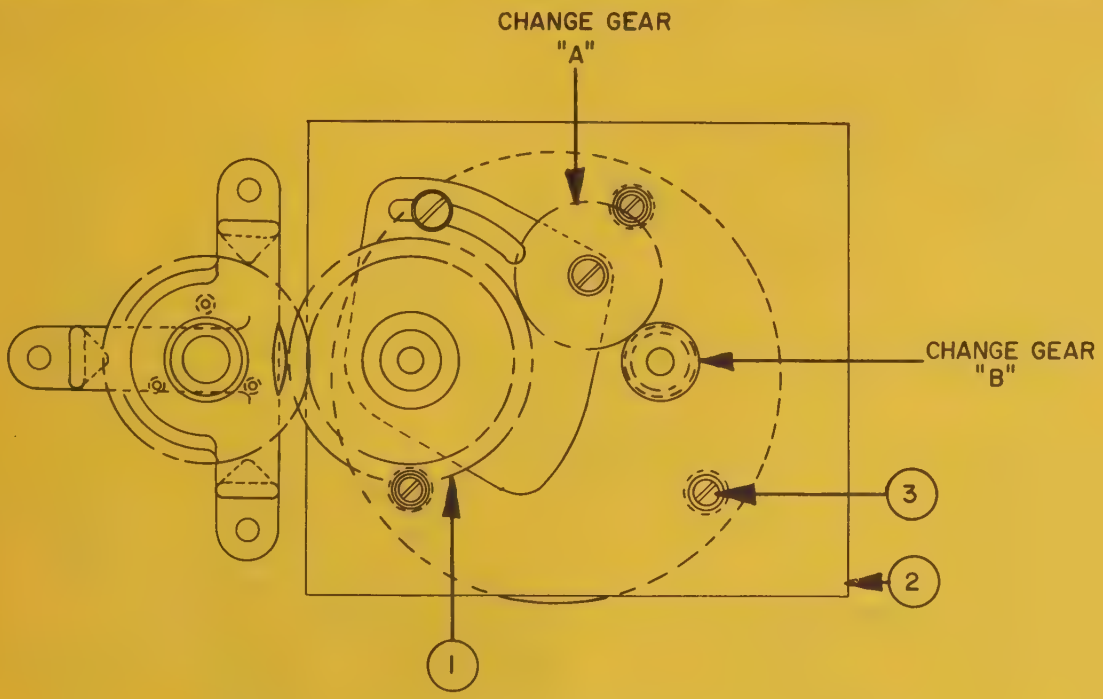


Figure 4. Optional cam drive with change gear assembly.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	A6966	Gear complete 78T and 96T
2	A6964	Mounting plate complete
3	20860	#4 - 48 x 1/4" Fillister-head screw
	A6916	Washer

INTERCHANGEABLE SPEEDS FOR TWO CASE RECORDING PROGRAM CONTROLLER SERIES 500

CAM DRIVE MOTORS						CHANGE GEARS			
PART 75303 30 MIN./REV.	PART 87351 96 MIN./REV.	PART 75308 6 HR./REV.	PART 75312 24 HR./REV.	PART 75314 72 HR./REV.	PART 75315 7 DAY/REV.	GEAR POSITION	NO. OF TEETH	PITCH	PART NO.
TIME PER CAM ROTATION									
10 Min.	32 Min.	2 Hr.	8 Hr.	1 Day		A B	96 54-18	48 48	A6951 A6953
20 Min.	64 Min.	4 Hr.	16 Hr.	2 Day		A B	96 54-36	48 48	A6951 A6955
30 Min.	96 Min.	6 Hr.	24 Hr.	3 Day	7 Day	A B	96 54-54	48 48	A6951 A6958
40 Min.	128 Min.	8 Hr.	32 Hr.	4 Day		A B	48 54-36	48 48	A6950 A6955
60 Min.	192 Min.	12 Hr.	48 Hr.	6 Day	14 Day	A B	48 54-54	48 48	A6950 A6958
80 Min.	256 Min.	16 Hr.	64 Hr.	8 Day		A B	24 54-36	48 48	A6960 A6955
120 Min.	384 Min.	24 Hr.	96 Hr.	12 Day	28 Day	A B	24 54-54	48 48	A6960 A6958

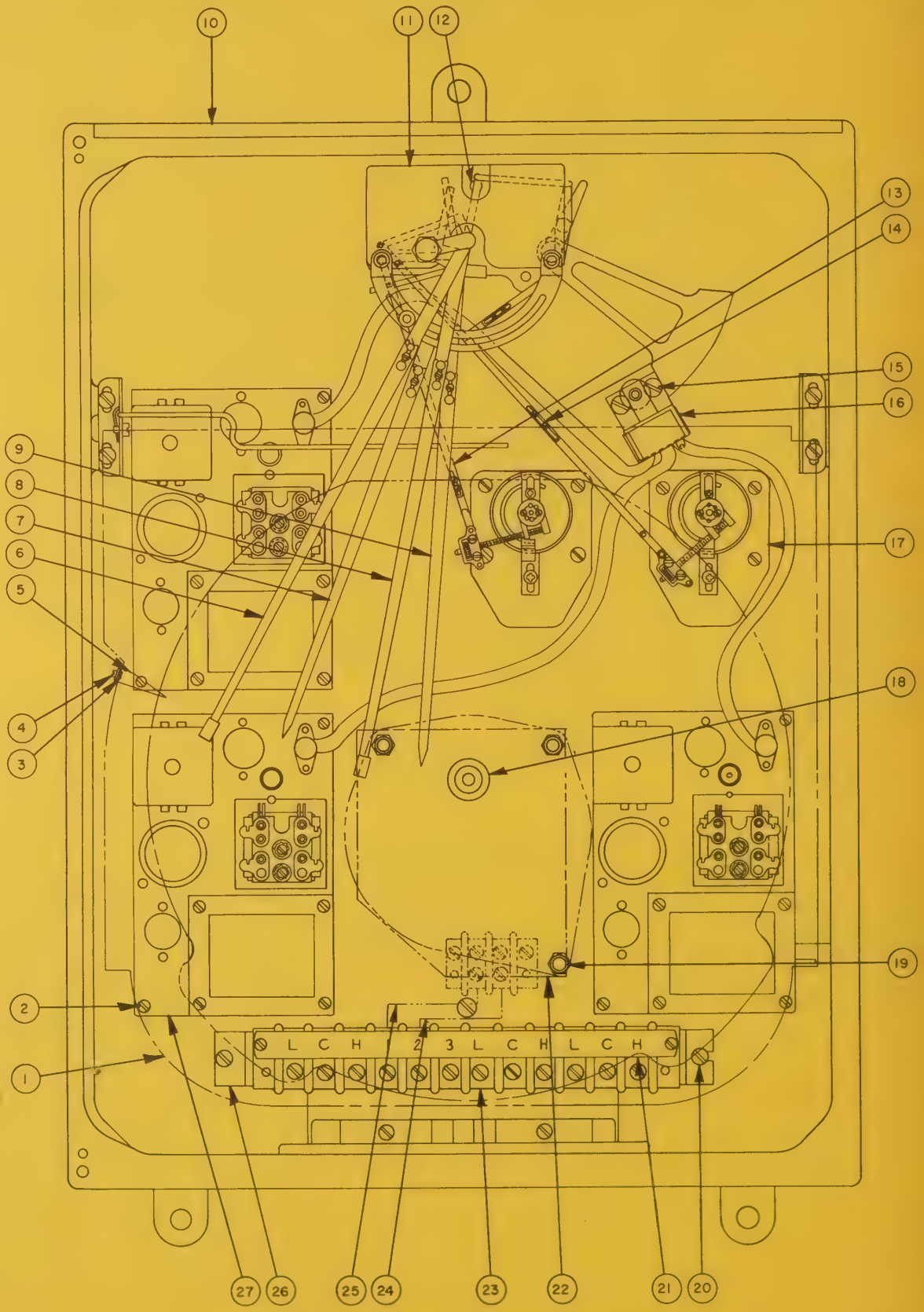


FIGURE 5. FRONT VIEW OF TYPICAL CONTROLLER CASE.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	84728	Dial
2	90670	#8-32 x 1 1/2" Fillister-head screw
3	87118	#2-64 Nut
4	67694	Hex head screw
5	84724	Time indicator
6	90651	Pen arm (FG) for No. 2 pen on a 2-pen instrument
	32915	Pen for No. 2 pen on a 2-pen instrument
7	90652	Control spotter arm
8	90650	Pen arm (FH) for single pen instrument and is No. 1 pen arm on a 2-pen instrument
	32914	Pen for single pen instrument and is No. 1 pen on a 2-pen instrument
9	90653	Control spotter arm
10		Case complete (specify model & serial numbers of instrument)
11		Differential pen mounting complete. (Specify model and serial No. of instrument.)
12	66545	#10-32 x 3/4" Fillister-head screw
13	86675	Adjustable connecting link
14	86678	Adjustable connecting link
15	66537	#10-32 x 1/4" Fillister-head screw
16		Control coil unit complete including mounting bracket and cable.
	B2213	For one-cam, one-control unit controller
	B2296	For one-cam, two-control unit controller
	B2212	For two-cam, two-control unit controller
	B2306	For two-cam, three-control unit controller
17		Measuring element. (Specify model, range & serial No. of instrument.)
18	74986	Chart hub
19	39770	#6-40 x 1/4" Fillister-head screw
20	66537	#10-32 x 1/4" Fillister-head screw
21	A6716	Marking strip
22		Chart drive specify spindle speed, voltage, frequency and type of motor.
23	88098	Terminal block (12 point)
24	86745	Pigtail (white) } order only with electric chart drive
25	86746	Pigtail (black) }
26	76253	Terminal block mounting bracket
27	90578	Control unit complete (50-60 cycle) see pages 8 & 9 for breakdown

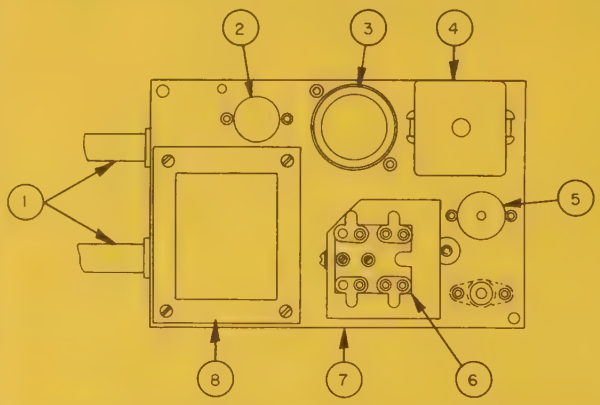


Figure 6. Top view of electronic control unit.

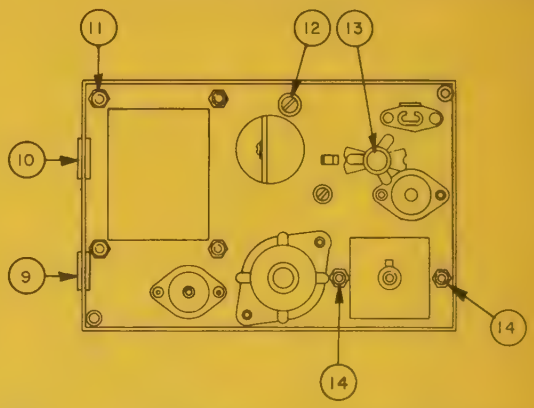


Figure 7. Bottom view of electronic control unit.

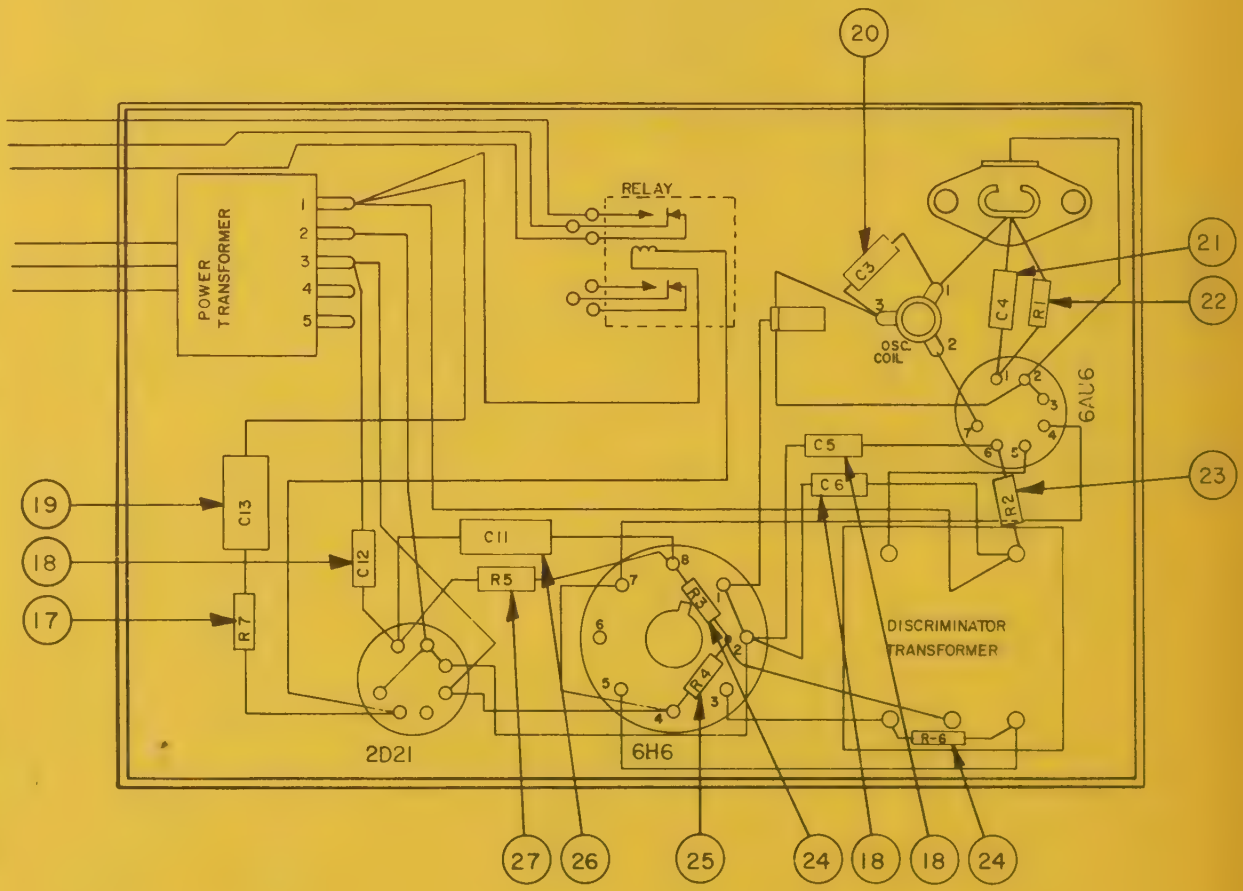


Figure 8. View showing components of electronic control unit.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	85108	Insulation sleeving
2	90555	Tube 2D21
3	90553	Tube 6H6
4	90573	Discriminator transformer
5	90554	Tube 6AU6
6	90570	Relay
7	C1091	Chassis complete
8	90576	Power transformer 50-60 cycle
	90577	Power transformer 25 cycle
9	95912	Grommet
10	79767	Rubber grommet
11	92923	#6-32 Hex nut
	33982	#6 Lockwasher
12	63384	#6-32 x 5/16" Fillister-head screw
	33982	#6 Lockwasher
13	90569	Oscillator coil
14	92923	#6-32 Hex nut
	33982	#6 Lockwasher
17	A2886	(R7) Resistor, 270 ohms
18	90560	(C5, C6, C12) Capacitor 750 MMFD
19	92727	(C13) Capacitor, 8 MFD
20	91431	(C3) Capacitor, 55 MMFD
21	90562	(C4) Capacitor, 39 MMFD
22	90556	(R1) Resistor, 15,000 ohms 1/2 watt
23	83977	(R2) Resistor, 47,000 ohms 1 watt
24	90557	(R6) Resistor, 270,000 ohms 1/2 watt
25	87019	(R3) Resistor, 150,000 ohms 1/2 watt
26	77701	(C11) Capacitor, .05 MFD
27	89087	(R5) Resistor, 2.2 megohm 1/2 watt

INSTRUCTION NO. Y19174

(Replaces issue of 11/49)

METHOD FOR CUTTING CAMS ON TIME-PROGRAM CONTROLLERS

Herewith: sheets 013358, 018689 and 018691

NOTE: This instruction covers the method for cutting both metal cams and transparent cams used on various types of Program Controllers.

Metal cams are used primarily on 2-case Series 500 Program Controllers.

Transparent cams are used primarily on single-case Series 500 Program Controllers and on Dynamaster* Program Controllers.

PART I METAL CAMS

UNPACKING: Be sure to remove shipping clamp holding cam follower to cam-motor hub before attempting to operate a Series 500 Controllers.

The following instructions describe the marking and cutting of a metal time-temperature-program cam for a Series 500 Controller. It applies equally to cam cutting for any other measured variable program controllers.

A. General

1. Note that curved time lines printed on cams may curve one way or the other as illustrated in figures 1 and 2. Select, as a working example, that figure similar to the cam being cut.

2. Metal cams may be easily cut with ordinary tin shears.

B. Marking Time Schedule on Metal Cams

1. All cams used on Series 500 Program Controllers rotate in a counterclockwise direction. In laying out the time schedule, always proceed in the opposite direction of the cam rotation.

2. Note time required for one revolution of cam. This time may be found on face plate of cam-driving mechanism and name plate of the instrument. Count number of time intervals printed on cam and determine number of minutes or fraction of an hour corresponding to one time interval. (Examples are given below.)

C. Marking of Cam to Compensate for Radius of Cam-Follower Roller.

1. For a uniform temperature rise, compute number of degrees per time interval and mark cam accordingly in a dotted, smooth curve. A sharp pencil is satisfactory for marking a temperature curve on a metal cam.

2. After dotted line has been laid out, a pair of dividers may be used to scribe a solid line 3/32" inside the dotted line as shown in figures 1 and 2. Cut cam along this solid line. This compensates for radius of cam-follower roller. Any irregularities may be smoothed out by means of a small file. If the rate of rise is critical the edge of the cam should be smoothed by a fine emery cloth or crocus cloth.

3. **Example A.** See Figure 1.

Time required for one revolution of cam: 6 hours or 360 minutes

Number of time intervals printed on cam: 180

Time corresponding to one interval: 2 minutes

Raise temp. to 90°F in 10 min.
Hold temp. at 90°F for 60 min.
Raise temp. at 210°F in 60 min.
Hold temp. at 210°F for 60 min.
Lower temp. to 200°F.
Hold temp. at 200°F for 20 min.
Raise temp. to 210°F for 6 min.
Hold temp. at 210°F for 60 min.
Lower temp. to 200°F.
Hold temp. at 200°F for 20 min.
Temperature drops: End of schedule.

4. **Example B.** See Figure 2.

Time required for one revolution of cam: 12 hours or 720 minutes

Number of time intervals printed on cam: 144

Time corresponding to one interval: 5 minutes

* Reg. U.S. Pat. Off.

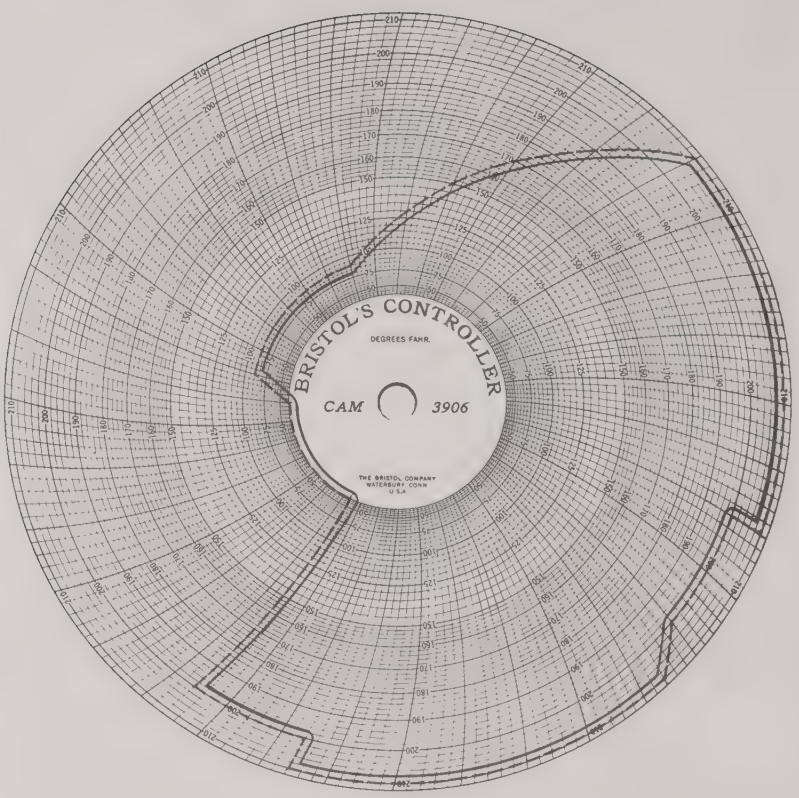

BRISTOL'S CONTROLLER
DEGREES FAHR.
CAM
3906
THE BRISTOL COMPANY
WATERBURY CONN
U.S.A.

FIG. 1

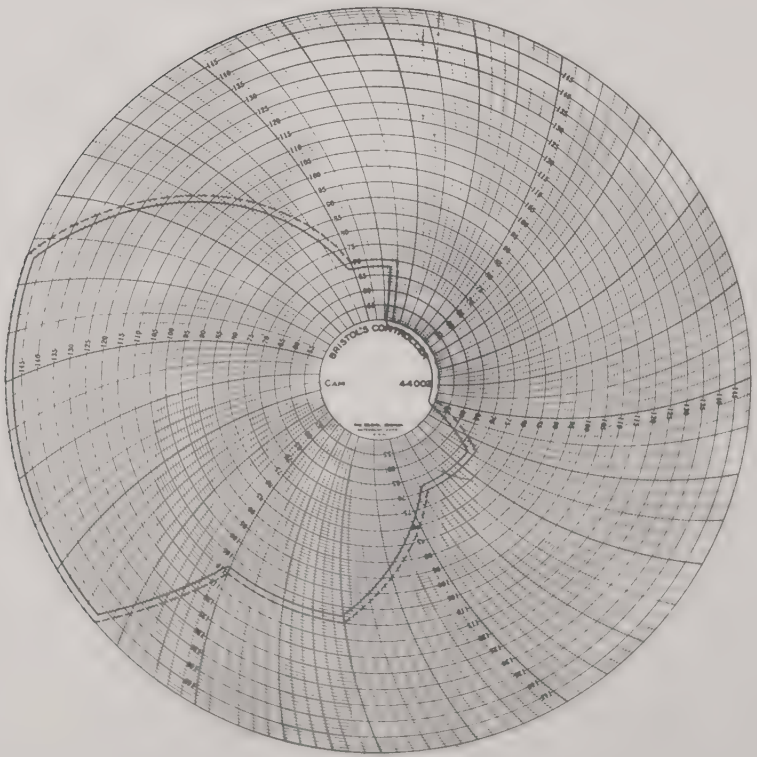

BRISTOL'S CONTROLLER
CAM
4400

FIG. 2

Raise temp. to 70°C in 40 min.
Hold temp. at 70°C for 60 min.
Raise temp. to 110°C in 80 min.
Hold temp. at 110°C for 60 min.
Raise temp. to 150°C in 40 min.
Hold temp. at 150°C for 120 min.
Lower temp. to 70°C in 80 min.
Hold temp. at 70°C for 45 min.
Lower temp. to 50°C.

D. Marking of Cam Without Compensation for Radius of Cam-Follower Roller.

If a small error or discrepancy between the program cut on the cam and that duplicated by the controller is not objectionable, the undercutting of the cam mentioned in the previous paragraph can be dispensed with.

These errors will be as follows:

Time error ± 2% max. to zero min.

Measured variable error + 2% max. to zero min.

This does not mean that the controller or the record will be incorrect but merely that the actual program produced will differ from that cut on the cam.

E. Maximum Rise

It is obvious that too steep a rise in the cam would require considerable power in the cam-driving mechanism. The geometry of the cam-drive is such that the drive is capable of overcoming a rate of rise on the cam which is a minimum at the center of the chart and a maximum at the outside. This means that the cam curve that will change the follower from zero to 100% of scale in the shortest period of time is one which will have an increasing rate of rise.

There are several factors which determine the maximum rate of rise such as weight of links, one or two cams etc.

Included with this instruction are drawings outlining three full scale templates to be used in checking any particular cam rise. Sheet No. 018691 is for a pneumatic controller with an electric drive. Sheet No. 018689 is for a pneumatic controller with a spring-wound drive. (The electric drive produces more torque than the spring wound and hence will pull over a steeper rise.)

When a template is cut out, it should be rotated around the cam center to see that the slope on any portion of the program outline does not exceed the rise represented by the reference edge of the template.

F. Two-Cam Controller

On controllers with two cams, it is sometimes desireable to pin the cams together in order that the cams will always have the same relationship with each other.

After the cams are properly cut, remove the cam hub from the instrument. Next, remove the pin that is screwed into the hub. Place cams on the hub in the required relationship.

With a #46 (.081") drill, drill a pilot hole thru both cams using the hole, from which the pin was removed, as a guide. Then, remove the cams and enlarge the hole in each cam with a #38 (.012") drill.

Replace pin in hub and replace hub on instrument. Replace cams using pin as a guide for proper placement. As the cams cannot be put on but one way, that is with the pin thru hole, this assures that the cams will always be in the same relationship with each other.

G. Punching Holes in Cam

This paragraph applies only to those time-program controllers with jet-arrangement cam follower.

After cam has been cut as directed above, the holes required for manual operation points should be punched as follows:

The holes should be punched such that the jet on the cam follower will be uncovered and then covered. The operating point will be at the point of recovering the jet or at the trailing edge of the hole.

The placing of the hole will be such that the trailing edge will be on the time arc of the operation desired. This may be according to time or temperature position.

When the time arc for punching is determined, measure in 13/32" and punch the hole. This distance is the amount of offset between the jet and cam-follower roller. The hole should be 1/16" in diameter.

Care should be taken when cutting cam profiles and laying out cam schedules to see that rises and drop-offs are not at extreme angles to permit the jet to become uncovered.

The cams may be punched with a hand punch or drilled with a 1/16" drill.

H. Blank Cam

In case a blank cam is furnished, a paper chart may be pasted on the blank can and the cam then cut as per above instructions.

J. Schedule Records

It is advisable to enter each different time-temperature or time-pressure cam schedule on a card which is numbered and filed for convenient reference. The card numbers may be marked on the corresponding cams and the cams filed numerically.

PART II CUTTING TRANSPARENT CAMS

A. How to Cut Transparent Cams

1. Transparent cams may be cut with a band saw and then filed smooth. It is first necessary to outline in pencil on a chart the particular program desired. There is a limit to the amount of rise at any particular point on the chart.

2. A drawing is provided with this instruction, outlining a convenient template to be used in checking any particular cam rise. This template may be cut out of transparent celluloid or other transparent material, or of necessity may be used as is.

3. When the template is cut out, it should be rotated around the chart center to see that the slope on any portion of the program outline does not exceed the rise represented by the reference edge of the template.

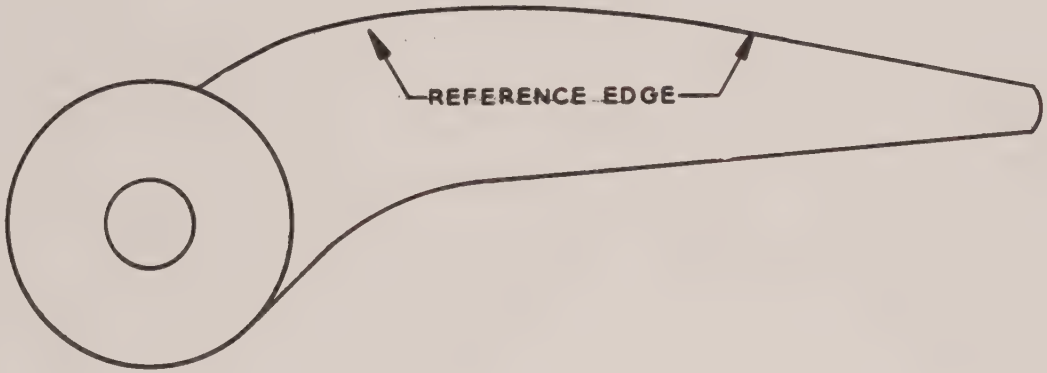
4. When a rate of rise greater than that of the template is required, the Bristol Company Engineering Department should be contacted.

5. After the program outline has been correctly drawn on the chart, place the transparent cam over the chart, making sure to center the cam over the chart. With any pointed instrument, scribe the outline of the program on the cam. Then cut the cam on a band saw as close to the scribed line as practical and then file the balance smooth to the exact program line.

The Bristol Company
Waterbury 20, Conn., U.S.A.

Printed in U.S.A.

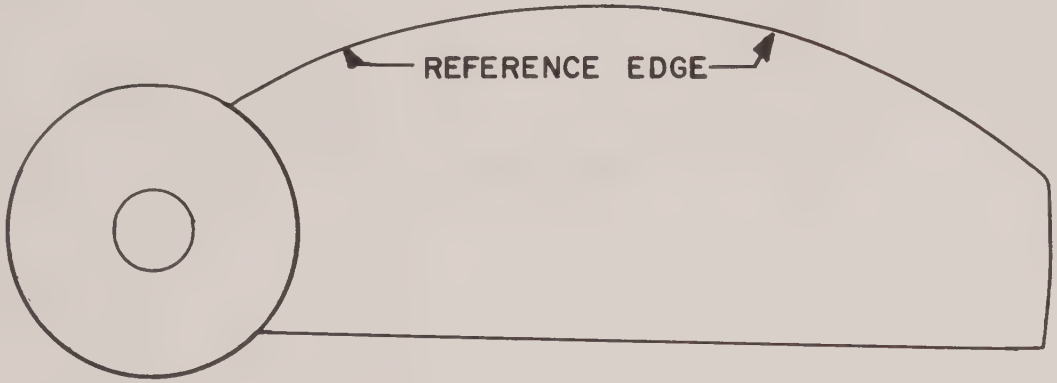
NOTE: THE SLOPE OF ANY CAM RISE SHOULD ALWAYS BE WITHIN THE SLOPE REPRESENTED BY THE REFERENCE EDGE OF THE TEMPLATE. SEE INSTRUCTIONS W18210-A



DRAWING OF TEMPLATE USED TO CHECK CAM SLOPES ON TIME PROGRAM CONTROLLERS IN SERIES 565 CASE

7-21-52 I.J.F.
21
013358

NOTE: THE SLOPE OF ANY CAM RISE SHOULD ALWAYS BE WITHIN THE SLOPE REPRESENTED BY THE REFERENCE EDGE OF THE TEMPLATE



689810 ON

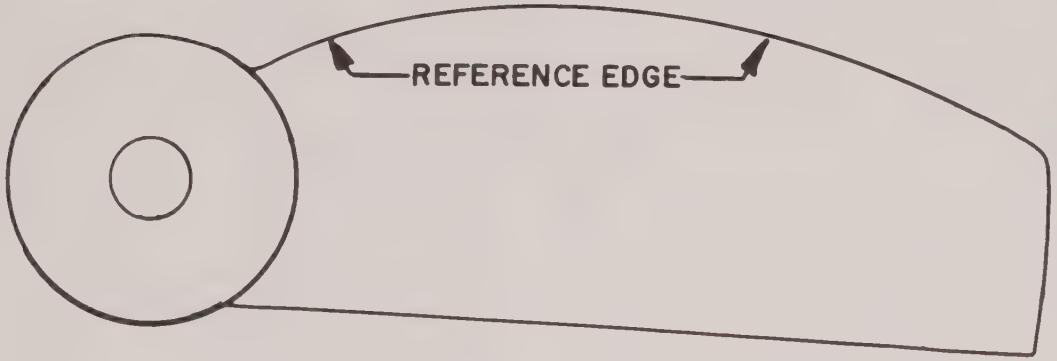
TEMPLATE FOR MAXIMUM RISE OF CAM ON TIME PROGRAM CONTROLLER IN THE SERIES 500 CASE WITH SPRING CHART DRIVE

DRAWN REW	DATE 12 20 60	
TRACED	CHECKED	APPROVED
SCALE	FILE DR 21	
NO. 018689		

REVISIONS

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

NOTE: THE SLOPE OF ANY CAM RISE SHOULD ALWAYS BE WITHIN THE SLOPE REPRESENTED BY THE REFERENCE EDGE OF THE TEMPLATE.



NO. 018691

TEMPLATE FOR MAXIMUM RISE OF CAM ON TIME PROGRAM CONTROLLER IN THE SERIES 500 CASE WITH ELECTRIC CHART DRIVE

DRAWN REW	DATE 12-20-60
TRACED	CHECKED / APPROVED
SCALE	FILE DR. 21
NO. 018691	

REVISIONS

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

156 IMPERIAL 64822

Instruction Y19800
Issued 6/54

INSTRUCTION NO. Y19800

(Issue No. 5 of 6/54)

INSTALLATION AND SERVICE OF BRISTOL'S STANDARD MODEL 500 AND 530 CASES

TABLE OF CONTENTS

	Page
PART I GENERAL	2
A. Description	2
B. Accessories	2
PART II INSTALLATION	2
A. Location	2
B. Mounting the Case	2
1. Surface Mounting	2
2. Flush Mounting	2
3. Flush Mounting (Special)	2
PART III CASE CONNECTIONS	3
A. General	3
B. Standard Connection Sequence	3
C. Color Coding for Multiple-pen Recorders	3
D. Air-control Connections	3
E. Case-connection Fittings	3
PART IV CASE CHANGES AND SERVICE	3
A. General	3
B. Changing from Back to Bottom Connected	3
C. Changing from Bottom to Back Connected	4
D. Service and Repair	4

THE BRISTOL COMPANY WATERBURY 20, CONN.

PART I GENERAL

A. Description

Bristol's Model 500 and 530 Cases include many valuable features, such as uniformity of design and function, interchangeable mounting accessories (surface or flush), universal connection plates, etc. Case sizes are based on the nominal chart or dial dimensions. The Model 500 case is called the 12" case, and the Model 530 is called the 8" case.

B. Accessories

All Bristol Instruments are provided with mounting accessories for surface or flush mounting as specified on the sales order. In addition, other accessories, such as fixtures, extra parts, etc., may be supplied. These are always packed with the instrument and are itemized on the packing list. Do not throw away the packing until everything has been located and identified.

PART II INSTALLATION

A. Location of the Instrument

Select a location as free as possible from dust, dirt, corrosive fumes, vibration and extremes of temperature. Although Bristol instruments will operate satisfactorily under unfavorable conditions, the life and effectiveness of the instrument can be prolonged by using a recommended location.

B. Mounting the Case

Always mount the case vertically and level. Use a spirit level or plumb bob to check this. See Instructions Y19809 for mounting dimensions.

1. Surface Mounting. Surface mounting refers to any vertical surface, such as a wall, bracket or any other structure upon which the instrument may be fastened. Drill three 5/16" holes to take 1/4" bolts or wood screws according to mounting-dimensions drawing.

Attach the three brackets to the instrument in the surface-mounting position as shown in Figure 1 and fasten it securely to the surface.

2. Flush Mounting. Flush mounting means inserting the entire instrument into an opening so that only its door protrudes beyond the surface of the panel, wall or other mounting place. Cut out the hole in panel according to mounting-dimensions drawing. The maximum thickness of the panel cannot exceed 1 7/8" except for the bottom-connected 4-pen recorder with electric chart drive; this panel thickness cannot exceed 5/8".

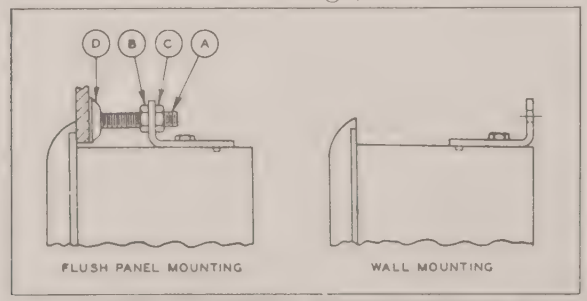


FIGURE 1. MOUNTING BRACKET POSITIONS

Allow horizontal space between instruments as specified in the mounting dimensions to give door clearance. Vertical space between instruments should not be less than 5" when they are flush mounted, back connected. Allow more between bottom-connected instruments.

After the hole is cut in the panel, remove the mounting bracket from the top of the case, unscrew all case connections (except thermometer tubing and filled pressure seals - see paragraph 3 below), and insert the back of the instrument thru the hole, bottom first. On thicker panels it may be necessary to remove all three mounting brackets. Have someone hold the instrument in front while the brackets are being replaced. After mounting brackets are replaced, loosen nuts B and C and screw A. Force screw A against reinforcing disc D. Turn nut B until snug against mounting bracket. Tighten screw A Lock in place by tightening nut C with a wrench. It is not necessary to tighten nut B with a wrench.

3. Flush Mounting of Bottom-connected Thermometers and Pressure Gauges with inseparable pressure seals. Case connections for these instruments cannot be removed, and extra clearance in panel cutouts must be allowed. See notes on mounting-dimensions drawing, Y19809. Gauges and thermometers in Model 530 (8") case may need wooden shims between the case bottom and the panel if the panel is over 1/2" thick. Be careful not to bend severely or pull on thermometer and seal tubing.

PART III CASE CONNECTIONS

A. General

The Model 500 and 530 cases are provided with a universal connection plate (Figure 2) which can be used for bottom or back connections and can be changed at any time.

Before making any connections to your instrument, check the voltage and frequency specified on the instrument nameplate and study the wiring diagram provided (wiring diagrams are generally not provided when the only electrical connections are for a chart drive).

B. Standard Connection Sequence

Measuring elements, chart drive, etc., are always connected in a standard sequence in Model 500 and 530 cases for gauges and thermometers. Separate diagrams are always furnished with gauges and thermometers, showing the standard connection sequence.

C. Color Coding for Multiple-pen Recorders

Each measuring system in Bristol's multiple-pen recorders is identified by a standard color code. The color for each system is listed on the instrument nameplate inside the case door. This color is painted on each pen arm, set-point index, set-point knob, case connection and also on thermometer bulbs (if used). The color of the recording ink also corresponds to the color code.

D. Air-control Connections

Case connections for supply and output air for pneumatic controllers are not made thru the universal connection plate, but at separate connections shown in the mounting dimensions for such instruments.

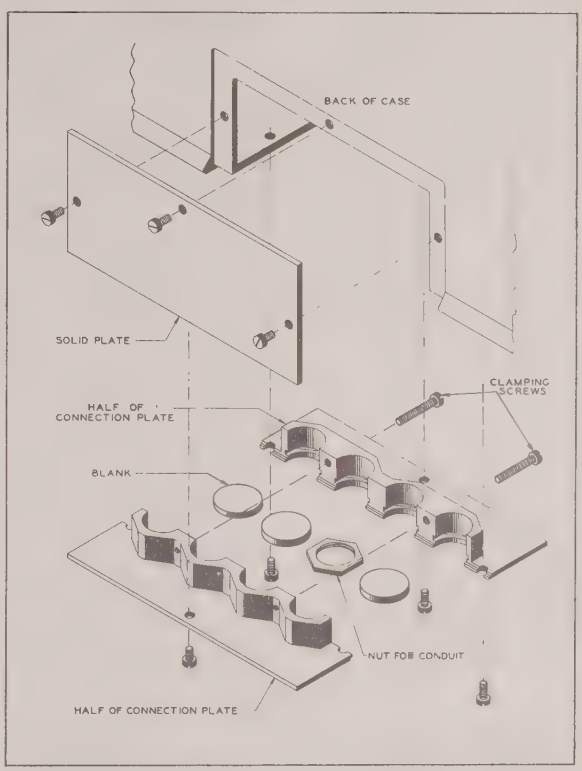


FIGURE 2. EXPLODED VIEW OF UNIVERSAL CONNECTION PLATE

E. Case-connection Fittings

A number of different fittings are available for standard conduit, pipe, electrical wiring, tubing, etc. A blank may be supplied to seal any unused connection holes.

PART IV CASE CHANGES AND SERVICE

A. General

Case-connection changes can be made without extra parts, using only a screwdriver. If different fittings are required (see paragraph D above), they may be ordered from Parts List Y19807.

All changes are made from the outside of the instrument case.

B. Changing from Back to Bottom Connected

Uncouple all inflexible connections to the connection plate, such as pipe, conduit, etc. (Do not attempt to remove thermometer tubing or other sealed systems.) Remove the solid plate from the bottom of the case by taking out the four screws holding it (a surface-mounted case will have to be removed from the surface upon which it is mounted). Then remove the three screws holding the connection plate, being careful to hold the plate so that it will not damage the tubing or other connections which cannot be removed. Do not unclamp the connection plate.

Now move the connection plate from the back to the bottom position, being careful not to damage the flexible connections. Fasten the connection plate into the bottom position and the solid plate into the back position. If you have removed a surface-mounted case, replace it on the surface. Attach any couplings, conduit, etc., that might have been removed while making the change.

C. Changing from Bottom to Back Connected

The same procedure outlined in paragraph B above is followed when changing from bottom to back connected.

D. Service and Repair

Parts List Y19807 gives a complete list of all the parts of the Model 500 and 530 cases. Order replacement and spare parts from this list.

The Bristol Company
Waterbury 20, Connecticut., U.S.A.

Printed in U.S.A.

INSTRUCTION NO. Y19802

OPERATION AND SERVICE OF ROUND-CHART RECORDING SYSTEM

NOTE: This instruction covers only the recording system. See separate instructions covering the measuring system, control system, etc.

A. Unpacking

1. Standard Recorder Accessories. Every Bristol round-chart recorder is supplied with one of each of the following items:

box of 100 charts, range and chart number as ordered.

1-ounce bottle of ink with dropper. Multiple-pen instruments get a 1-ounce bottle of different color ink for each pen supplied.

pen cleaner wire (.005" diameter) with instructions in envelope

brass chart-drive key (spring drive only)

FIGURE 1. QUICKSET CHART HUB - OPEN

2. Shipping Devices

a. Remove and discard the paper packing support under pen arm.

b. Remove from under chart hub the circular instruction on the operation of Quickset chart hub. Read this instruction carefully.

B. How to Change Charts

1. Push pen lifter down in order to hold pens and pointers away from chart.

2. Tip up Quickset chart hub, as shown in Figure 1, and slip off the old chart.

3. If instrument has a spring chart drive, wind chart drive by inserting brass key thru hole in chart plate.

4. Slip new chart over chart hub, under slot (18) in chart plate and under time index (3). Turn chart by hand until time index points to correct time. **Note:** Pens on multiple-pen recorders, in order

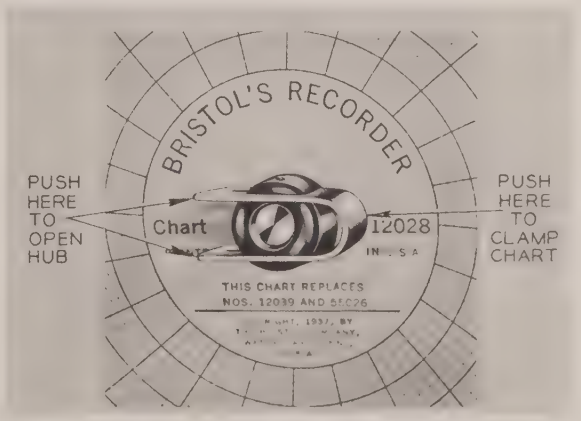


FIGURE 2. QUICKSET CHART HUB - CLOSED

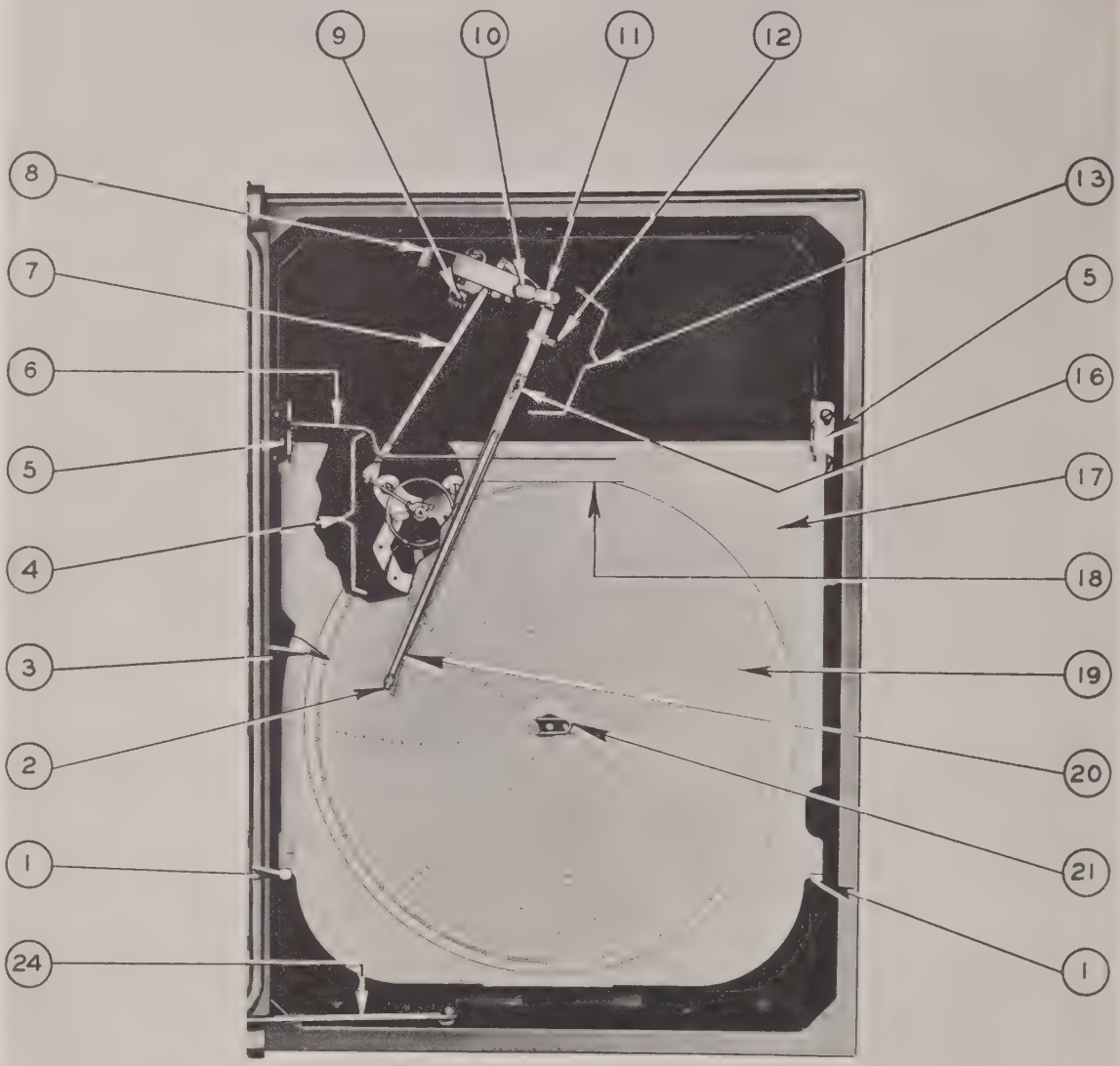


FIGURE 3. TYPICAL SERIES 500 RECORDER

to pass each other, cannot all swing on the same time arc of the chart. Therefore, the time index on such recorders is adjusted to indicate the time of the red pen, which is the only pen that follows the arc of the chart. Allowance must be made for this time difference between pens when reading charts made by multiple-pen instruments.

5. Turn chart hub down as shown in Figure 2 and push firmly on its curved end in order to hold chart. **Note:** Dairy recorder chart hubs are made with a pin which perforates the chart to prevent its being rotated by hand once it has been clamped down. Be sure to turn chart of dairy recorders to correct time at time index before pushing chart down over pin.

6. Add ink to pen or pens per paragraph C.2, page 3.

7. Lower pen or pens gently onto chart by pushing pen lifter upward.

Code To All Photos

1. Spring catch for chart plate
2. Pen
3. Time index
4. Measuring element
5. Chart plate bracket
6. Pen lifter
7. Measuring element connecting link
8. Universal pen mounting
9. Screws holding above
10. Cap screws holding tabs
11. Bearing tab
12. Micro adjustment
13. Base end of pen
14. Pen shaft lever
15. Pen shaft
16. Screws holding pen arm
17. Chart plate
18. Slot to hold top of chart
19. Recording chart
20. Pen arm
21. Quickset chart hub
23. Universal connection plate
24. Door stop
30. Speed regulator of spring chart drive
31. Start knob
32. Screws holding spring drive in case
33. Winding arbor
34. Screws holding drive cover
35. Gear change speed indicator
36. Gear change knob
37. Spring drive cover
40. Laminated core
41. Name plate of telechron motor
42. Gear train
43. Electric drive mounting plate
44. Electrical connection wires
45. Screws holding drive in case
46. Electric drive terminals
50. Shipping strap of complete motor unit
51. Motor shaft
52. Screws holding shipping strap
53. Rotor unit
54. Soldering lugs
55. Field coil
56. Location of "top" marking & rotor data
57. Rotor pinion gear
58. Screw holding motor into gear case
59. Copper shading coils

C. Pens

1. Types

a. Single-pen Recorders. Single-pen recorders are supplied with either a "V" pen or a fountain pen. Fountain pens and V pens are not interchangeable. A special fine-bore fountain pen is sometimes used for recording variables which change widely and often. If the ink record of your recorder tends to overlap and run, a fine-bore fountain pen should be obtained to replace the standard-bore fountain pen. For records of very long duration, standard-bore and fine-bore pens are available with large barrels holding 6 drops of ink. All standard- and fine-bore, 3- and 6-drop fountain pens are interchangeable.

b. Multiple-pen Recorders. Multiple-pen recorders are supplied with flattened fountain pens with capillary tips of different lengths so that they can pass each other on the chart. The pen nearest the chart is called the 1st pen, the next pen is called the 2nd pen, etc. Be careful not to bend pens (or pen arms) of multiple-pen recorders as they must pass each other without touching. Multiple-record instruments are supplied with a maximum of 2 pens on the 8" size case and 4 pens on the 12" size case.

All pens should be replaced as soon as the tip is worn, broken or corroded.

See parts list of recording accessories for complete listing of pens.

2. How to Ink and Start Pens. Pens, as supplied, usually will hold more than enough ink for one complete chart revolution. However, it is wise to refill pens every time the chart is changed.

a. V Pen. Fill V pens 2/3 full, using dropper from ink bottle supplied. If pen fails to trace when lowered on chart, touch its tip with a moistened finger.

b. Fountain Pen. Fill fountain pens to the top, using dropper from ink bottle. Standard pens take about 3 drops of ink. If pen fails to trace when lowered on chart, try touching tip of capillary tube with a moistened finger. If pen still fails to trace, pull pen off pen arm and squeeze between thumb and finger (as per Figure 4), then dip end of capillary tube in a drop of ink and release pressure of fingers. Replace pen by pushing pen all the way up on forked end of pen arm.

Use the 1-ounce bottle and pen filler furnished for re-inking pens. Buy recording ink in the economical larger size bottles and refill the 1-ounce bottles. See parts list of recording accessories for complete listing of all inks, bottles, and pen fillers.

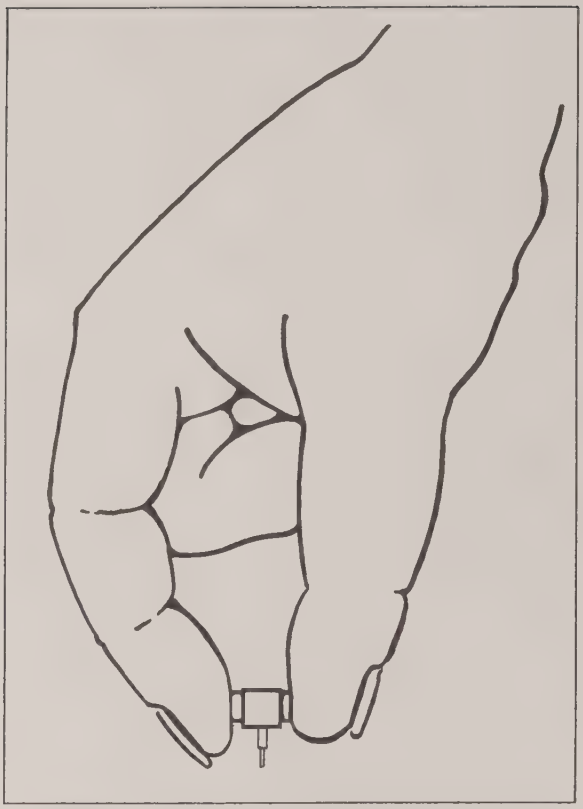


FIGURE 4. STARTING FOUNTAIN PEN TO INKING

3. How to Clean Pens. Pens should be cleaned periodically to forestall trouble because only a clean pen can trace a clean record.

To clean either a V pen or a fountain pen, loosen screw (16) holding pen arm and pull pen arm and pen off of base end (13). Wash pen in alcohol, ammonia or very hot water (if necessary, boil pen in water for a few minutes).

Clean out capillary tip of fountain pen by inserting pen cleaner wire supplied.

Replace pen arm and pen, being sure to push prongs of pen arm up under rivets on base end until it snaps into place. Retighten locking screw.

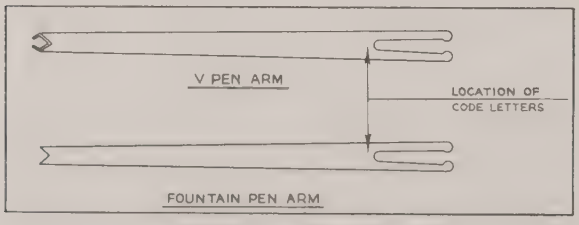


FIGURE 5. PEN ARMS

D. Pen Arms

Pen arms for V pens and for fountain pens (see Figure 5) are not interchangeable. Pen arms for 1st, 2nd, 3rd and 4th pens of multiple-pen recorders are of different lengths and, therefore, are not interchangeable.

All Bristol pen arms are identified by code letters stamped into their upper ends. Be sure to specify these code letters from your old pen arm when ordering replacements.

Do not bend pen arms. If the effective length of the pen arms is altered, the pen will not swing along the time arc on the chart and, therefore, will not record the measured variable correctly. If pen arms of multiple-pen recorders are bent, they will not pass each other freely.

E. Removing Chart Plate

The chart plate of Series 500 recorders can be removed without tools in the following manner:

Raise pen or pens by pushing down on pen lifter. Tilt up chart hub and remove chart. With thumbs of both hands, depress simultaneously 2 clips (Item 1 of Figure 3) and pull bottom of chart plate out and

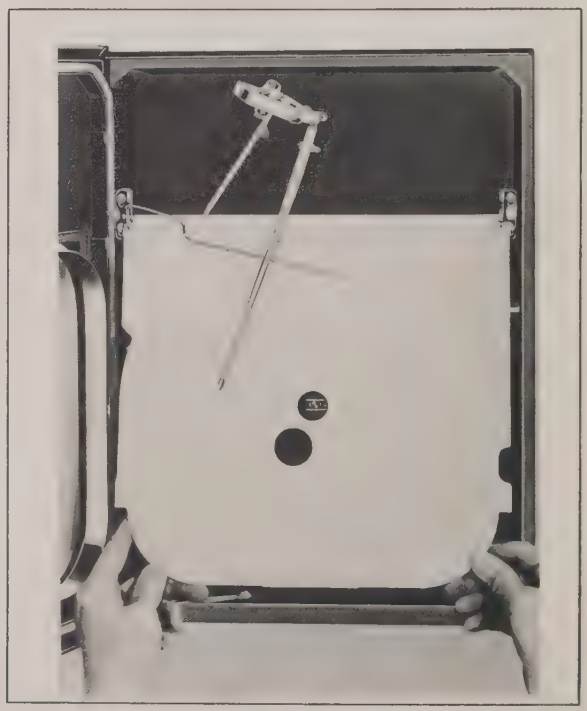


FIGURE 6. HOW TO REMOVE CHART PLATE

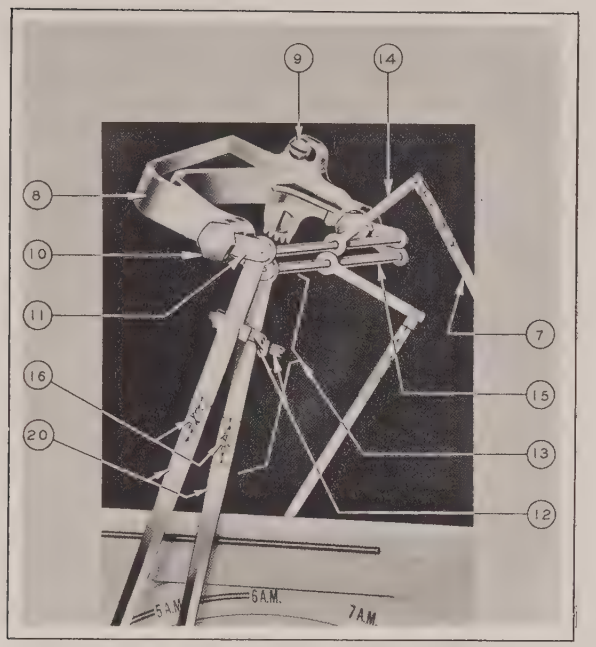


FIGURE 7. UNIVERSAL PEN MOUNTING - 2 PEN

down (see Figure 6). Chart plate may be replaced in the reverse order to above.

F. Pen Mounting and Base Ends

All Series 500 recorders are equipped with the same style universal pen mounting. Mounting parts can be easily replaced or mounting can be quickly converted to accommodate any multiple combination.

On most recorders the pen shaft (Item 15, Figure 7) can be removed by gently lifting top bearing tab (11) and slipping shaft out. Pen mounting can be disassembled by removing 2 screws (10).

Micro adjustment (12) is spring loaded to eliminate all lost motion. Its knob is both knurled and slotted for easy adjustment with fingers or a screwdriver. See measuring-system instructions for this adjustment.

A complete listing of all pen-arm mountings and parts is given in parts list for recording accessories.

G. Ink

1. Standard Color Code. The color of ink to be used in each pen of multiple-record instruments is painted on its pen arm or base end.

2. Standard Ink. Standard Bristol recorder ink will perform well at internal case temperatures from +10°F to +160°F (-23°C to +65°C).

3. Low-temperature Ink. Bristol low-temperature ink is recommended for case temperatures from -65°F to +80°F (-54°C to 26°C). It will flow evenly and will not freeze at these temperatures.

4. High-temperature Ink. Bristol high-temperature ink is recommended for case temperatures from +60°F to +500°F (+15°C to +260°C). This ink will not dry in pens or boil away when used between these temperatures.

5. Quick-Drying Ink. This type of ink is recommended with high speed charts (15-, 30- and 60-minute rotation) because it dries quickly and permits charts to be removed immediately when finished without smearing the record.

Quick-drying ink is also recommended where high humidity conditions exist.

Note: Use only Bristol recorder inks. Ordinary inks dry too fast, clogging and corroding pens. A complete listing of Bristol Company inks is given in parts list for recording accessories.

H. Chart Drives

All Bristol chart drives for round-chart recorders have identical mountings and are, therefore, interchangeable. Thus, chart rotation time or voltage and frequency used can be quickly changed. Spring and electric drives are also interchangeably mounted.

1. Service Chart Drives. All Bristol Branch and Main Factories carry stocks of carefully rebuilt, fully guaranteed spring and electric chart drives which will be exchanged for the same specification defective drive for a nominal charge. In

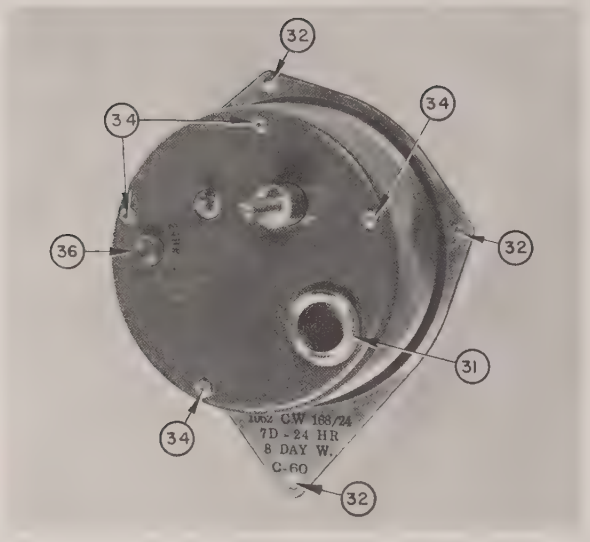


FIGURE 8. SPRING CHART DRIVE COMPLETE

order to positively identify correct speed, gear ratio, voltage and frequency, etc., we must receive your old chart drive before shipping the replacement service drive.

Instrument users having several Bristol recorders would do well to keep one or two, two-speed spring service chart drives in stock as universal standby replacements.

a. How to Wind. With chart removed, insert brass key thru hole in chart plate and wind arbor clockwise as far as it will turn. Wind all 7 and 8 day spring chart drives once each week. All other drives must be wound once each day.

b. Adjusting Speed. If chart revolves too fast or too slow, the speed of chart drive should be adjusted by turning adjusting lever in the direction required. Moving the lever clockwise makes the drive go faster and moving the lever counter-clockwise makes the drive go slower. Cap (item 31, fig. 8) must be removed to get at adjusting lever.

c. Two-speed Drives. Some spring chart drives are equipped with a gear changer to produce two different chart rotations, for example: 24 hour and 7 day. To change from one rotation to the other, turn knob (Item 36, Figure 8) in a direction to show the desired rotation time.

d. Lubrication. Under normal conditions a spring chart drive should be cleaned and oiled about once a year. Where severe conditions exist, more frequent cleaning and oiling will be required. Only an experienced clock worker with proper equipment should be allowed to completely service a chart drive. Unless such are available, we recommend that chart drives be returned to The Bristol Company for exchange. (See "Service Chart Drives" paragraph H.1.)

For servicing spring chart drives, proceed as follows:

1st. Remove 3 mounting screws (32) and take complete chart drive out of instrument case.

2nd. Remove chart hub by loosening its setscrew with a small screwdriver.

3rd. Remove 4 nuts (34) and pull off cover.

4th. Disassemble movement and soak all parts **except** main spring assembly in benzine. Shake off excess benzine and allow all parts to dry thoroughly.

5th. Oil the main spring liberally with Bristol clock oil, Part No. A3885.

6th. Reassemble movement completely.

7th. Apply a small amount of Bristol clock oil to each bearing with a toothpick. For internal case temperatures from -20°F to +120°F use Bristol Part No. A3885 oil.

8th. Replace chart-drive cover, being careful to correctly position start lever and gear-shift knob. Replace chart hub and remount drive in recorder case.

3. Electric Chart Drives. Electric chart drives are powered by a 2-watt, self-starting synchronous motor which depends for its timing on the frequency of the alternating-current supply. Therefore, the frequency must be exactly as listed on name plate to obtain accurate chart timing. Where frequency is unregulated, we recommend use of spring chart drives.

Most recorders require power-supply wires to be connected directly to the terminal block on the chart drive.

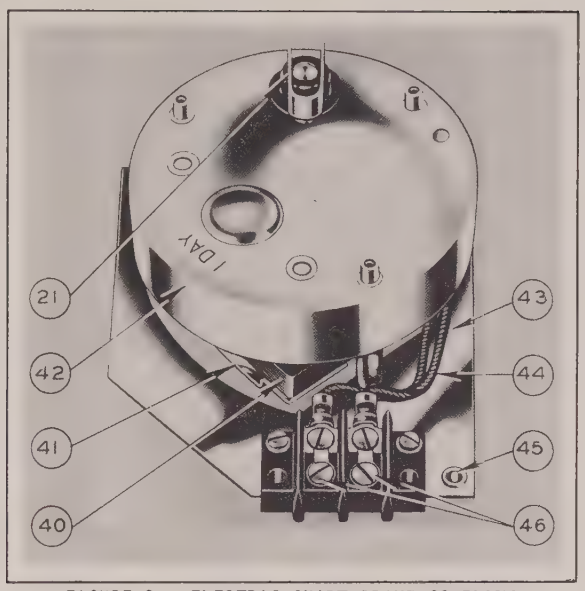


FIGURE 9. ELECTRIC CHART DRIVE COMPLETE

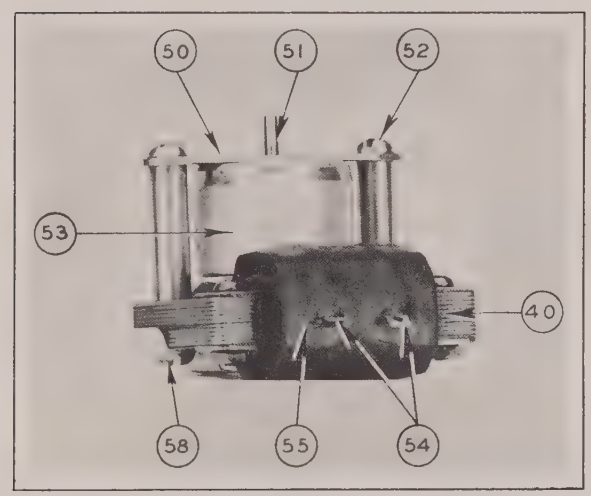


FIGURE 10. REPLACEMENT MOTOR (LESS PINION)

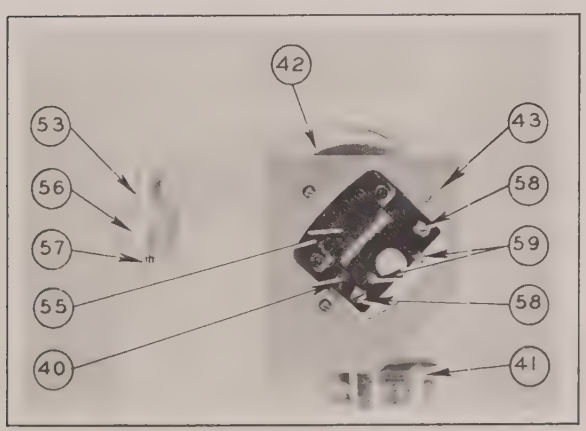


FIGURE 11. ELECTRIC CHART DRIVE PARTS

Caution: Before connecting power supply to chart drive, be sure to check on chart-drive base plate for correct voltage and frequency.

A supply-voltage variation of plus or minus 10% or less will not affect accuracy of timing.

There is no starting knob or speed regulator on electric chart drives. Electric chart drives will restart automatically after power failure, but the lost time must be made up by manually advancing the chart to correct time.

The Bristol Company can supply a reactor for installation in the chart-drive supply circuit to permit a 120-volt chart drive to operate on a 240-volt supply. This is especially convenient for portable test recorders, which can thus be operated from either 120- or 240-volt supply lines.

a. Replacement of Parts. Electric-chart-drive parts are supplied in three arrangements:

1. Complete drive as in Figure 9.
2. Motor unit complete as in Figure 10.
3. Rotor and pinion only shown in Figure 11. (Items 53, 56 & 57).

See parts list for complete chart-drive listing. As a rule either the motor complete or the rotor only need be replaced because of wear. Motor complete is furnished with shipping plate and screws to hold it together during shipment. These should be removed and discarded when motor unit is put into use.

By changing motor units and/or rotor units, any electric chart drive can be rebuilt to produce any standard combination of voltage and frequency. In ordering replacement parts, specify all data on the motor name plate. In ordering rotors, specify all data stamped on its barrel. Direction of rotation can be reversed by turning over the laminated magnet and field coil assembly (Items 40 and 55).

b. Disassembly of Chart Drive. Turn off power supply and disconnect leads from terminals. Unscrew 3 screws (45) and remove complete chart drive from

instrument case. Turn chart drive upside down and remove 2 screws (58) which permits rotor and motor to be removed from gear train. Note carefully position of the 2 copper shading coils (59) on laminated core before disassembly.

Replace rotor, motor, etc., as required and reassemble. Be sure to replace laminated magnet with copper shading coils (59) in same position as before. The direction of rotation of the rotor and consequently that of the chart can be reversed by turning magnet over and installing it with shading coils in the reverse position.

Note that the rotor has the word "top" stamped into edge of barrel. In assembling, turn rotor so "top" will be uppermost when chart drive is mounted in the instrument case to assure proper lubrication.

Replace chart drive in case and reconnect to power supply.

c. Lubrication. Rotor unit never requires lubrication. After 2 or 3 years use, the gear train only (motor and rotor removed) should be cleaned with benzine, allowed to dry and then oiled with Bristol clock oil Part No. A3885.

4. Combination Electric and Spring Chart Drives. When starting up for the first time or after prolonged shutdown, be sure to wind the spring in duplex chart drives. The spring drive will operate for an aggregate of 24 hours at one winding. When the spring is run down, a red signal (or indicator) will appear in a hole in the outer casing of the chart drive.

The combination electric and spring chart drive is wired in the same manner as the standard electric drive referred to in paragraph 3, page 6. If the electricity should fail, the spring drive unit starts immediately. The chart drive is fast acting in the change-over from electric to emergency operation and vice versa. A hairpin clutch and magnets hold the balance wheel at peak tension while the electric drive is in operation.

J. Repairs, Correspondence and Shipping

Address all correspondence and orders to the nearest Branch Office.

Ship all parts for repair or exchange only to Bristol Branch or Main Factory, never to Branch Offices. Identify all shipments fully, including your exact return address and repair order number. Be sure to state model and serial number of instrument in all orders and correspondence.

Addresses and phone numbers of Bristol Field Organization are listed on the last page of all instruction books.

The Bristol Company
Waterbury 20, Conn., U.S.A.

Printed in U.S.A.

CASE CONNECTIONS & MEASURING SYSTEM COLOR CODE FOR DIAL INDICATING & RECORDING THERMOMETER. 1 TO 4 PENS

TUBING & CONDUIT CONNECTIONS ARE MADE TO NUMBERED POSITIONS OF SPLIT CONNECTION PLATE AS SHOWN BELOW.

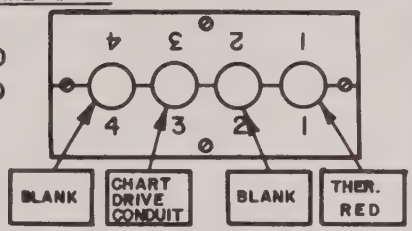
NOTE:
1. ALL CONDUIT CONNECTIONS ARE FOR 1/2" S.P.T.
2. OMIT CHART DRIVE CONDUIT FOR INDICATORS AND SPRING DRIVEN RECORDERS.

NUMBERS ARE FROM RIGHT TO LEFT LOOKING FROM REAR OF CASE

DRAWN J.J.R. | DATE 7/21/47 | APPROVED
TRACED J.A.D. JR. | CHECKED | FILE DR. 21
SCALE | NO. 011037

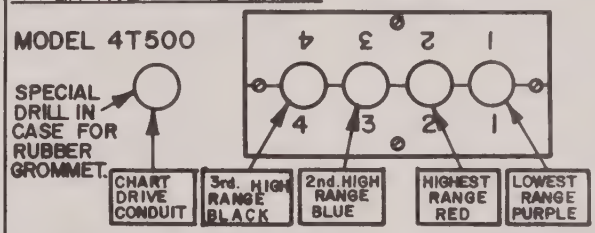
1 PEN THERMOMETERS

MODEL 1T500
MODEL 1T530



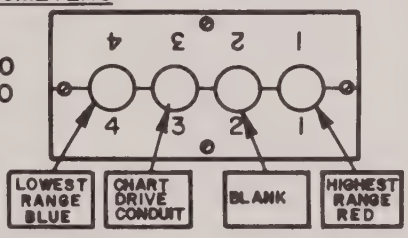
4 PEN THERMOMETERS

MODEL 4T500


SPECIAL DRILL IN CASE FOR RUBBER GROMMET.
4 3 2 1
4 3 2 1
CHART DRIVE CONDUIT
3rd. HIGH RANGE BLACK
2nd. HIGH RANGE BLUE
HIGHEST RANGE RED
LOWEST RANGE PURPLE

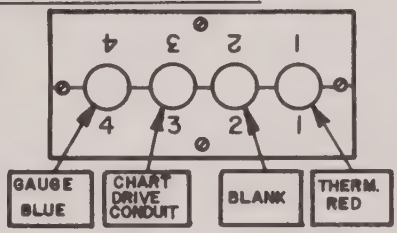
2 PEN THERMOMETERS

MODEL 2T500
MODEL 2T530



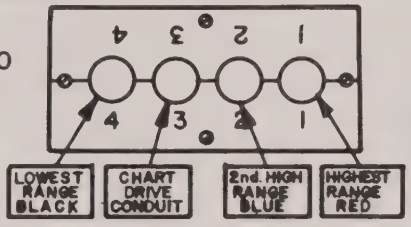
2 PEN 1 GAUGE & 1 THERMOMETER

MODEL IL500
MODEL IL530



3 PEN THERMOMETERS

MODEL 3T500



THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

REVISIONS	
4-12-48	
11-28-61	

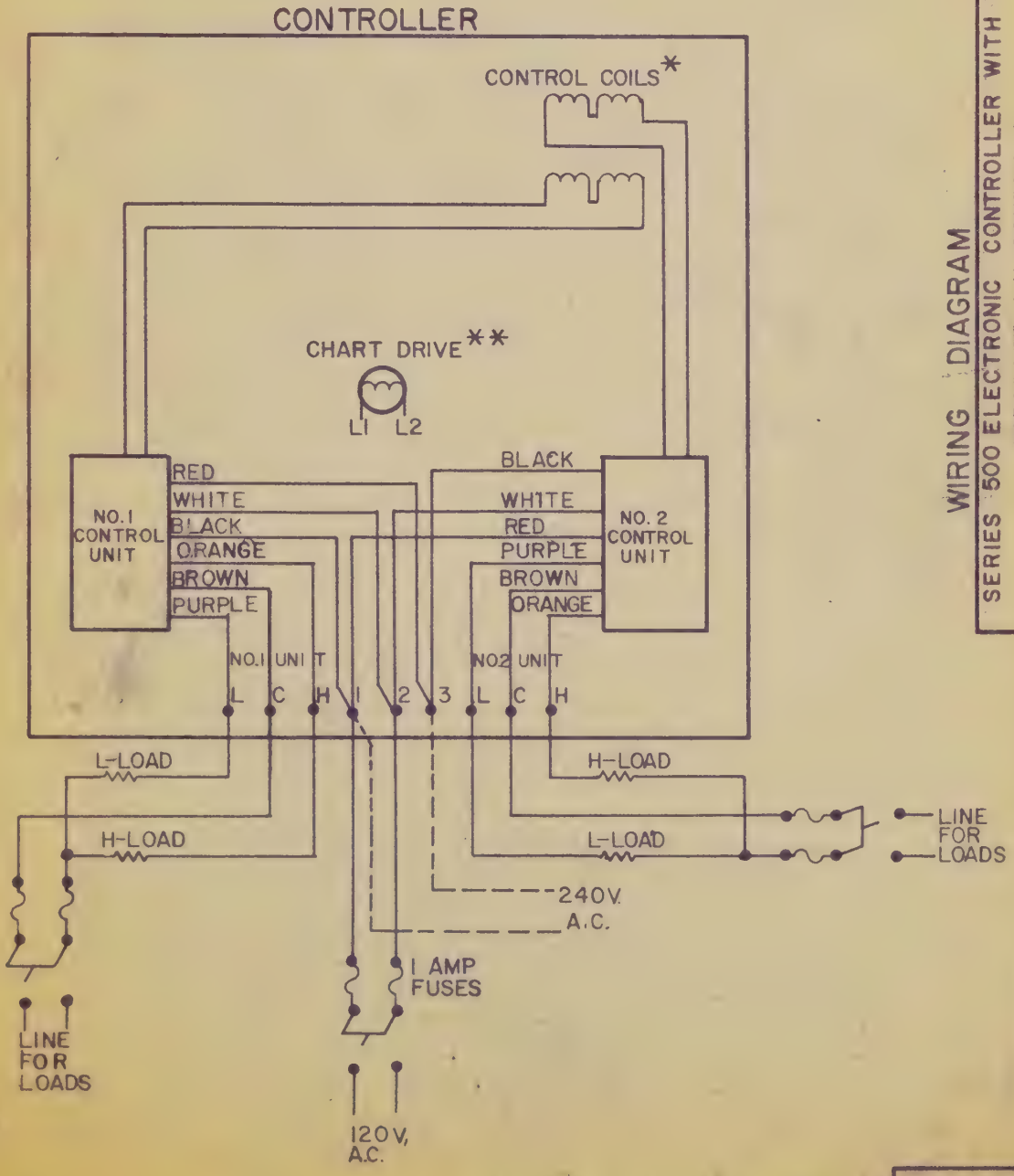
NO. 011037

NOTES:-

1. THE POWER SUPPLY TO THE CONTROLLER MAY BE EITHER 120 VOLTS OR 240 VOLTS A.C.
2. FUSED LINE SWITCHES FURNISHED BY USER.
3. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120V. A.C. OR 7.5 AMPS. AT 240V. A.C.
4. THE L OR H LOAD FROM EITHER UNIT MAY BE OMITTED.

* ON RECORDERS FRONT COIL CONNECTS TO RIGHT HAND CONTROL UNIT. ON INDICATORS FRONT COIL CONNECTS TO LEFT HAND CONTROL UNIT.

** CHART DRIVE OMITTED ON INDICATORS. FRONT VANE LEADS REAR VANE INTO CONTROL COIL.



WIRING DIAGRAM

SERIES 500 ELECTRONIC CONTROLLER WITH TWO SEPARATE LH CONTROLS.

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

DRAWN I.J.F | DATE 2/11/52 | APPROVED
TRACED | CHECKED
SCALE | FILE DR. 21
NO. 013008

REVISIONS
10/2/53

REDRAWN 2/25/60 JAD

NO. 013008

K&E 188 IMPERIAL 64922

Instruction W-18220
Issued April 1954

HOW TO ORDER PARTS AND SUPPLIES

FOR BRISTOL PRODUCTS

In all correspondence concerning any product of the Bristol Company, always give the model and serial number of the product concerned. Send your purchase order or quotation request to the nearest Bristol Company Branch Office (see the back of this sheet for addresses).

REPLACEMENT PARTS

When ordering replacement parts look up the part name and number in the parts list provided with the instructions that came with your product. When you cannot find a part number, give an accurate description of the part. If you have mislaid your parts list write for a new one giving the model and serial number of the product.

CHARTS

In ordering charts for recorders, give the chart number (printed on the chart and also on the instrument name plate).

Avoid inconvenient emergency orders by keeping a six months supply of charts on hand for each of your recorders.

THERMOCOUPLES

Pyrometer thermocouples should be ordered from Bulletin P-1238. Be sure to specify the catalog number and the length. If you do not have Bulletin P-1238, write for one.

Pyrometer users should always have a supply of spare thermocouples.

SAMPLE PURCHASE ORDER:

QUANTITY REQUIRED	DESCRIPTION	PART, CHART OR CATALOG NUMBER
1000	Charts, 0° to 1500°F	5342
5	7-day electric chart drive for 115 volts, 60 cycles	86226
4	Pen arms marked CD	49703
1	Knurled plastic knob on outside of case, ½" diameter, 3/16" hole for moving set-point index	none given
1	1 oz. bottle red ink	6883
	The above parts are for a Bristol thermometer controller Model 1T1X500B-2, serial number 767211.	
4	IC thermocouples, length 30"	3BS14N2
	The above thermocouples are for a Bristol pyrometer Model 487-L, serial number 202953	

THE BRISTOL COMPANY · Waterbury 20, Conn.

A SUBSIDIARY OF AMERICAN CHAIN AND CABLE CO. INC.

BRANCH OFFICES

ALABAMA
Birmingham 3, 1021 Comer Building ..... Alpine 1-0034
CALIFORNIA
Los Angeles 22, 6800 East Acco Street ..... Raymond 3-9751
San Diego 15, 7121E1 Cajon ..... Hopkins 3-9664
San Francisco 7, 40 Berry Street ..... Garfield 1-5462
COLORADO
Denver 16, 4555 East 46th Avenue ..... Dexter 3-6228
CONNECTICUT
Hartford ..... Jackson 7-2377
Waterbury 20, Bristol Road 756-4451
DELAWARE
Wilmington, 374 Delaware Trust Bldg. ..... Olympia 4-1183
DISTRICT OF COLUMBIA
Washington ..... Enterprise 1-5400
FLORIDA
St. Petersburg, 945 Central Ave. ..... Orange 1-5151
GEORGIA
Atlanta 3, 231 Healey Building ..... Jackson 2-7607
ILLINOIS
Chicago Area, 2040 No. Hawthorne Ave., Melrose Park, Ill.
Chicago Phone ..... Estebrook 9-6800
Suburban Phone ..... Murray 1-1450
INDIANA
Indianapolis 5, P.O. Box 55294 Uptown Sta..... Walnut 4-4343
IOWA
Davenport, 611 Kahl Building 323-1131
LOUISIANA
New Orleans 12, 504 Delta Building 523-5522
MARYLAND
Baltimore 14, 5439 Hartford Road, Rm. 101 .. Hamilton 6-5766
MASSACHUSETTS
Boston 16, Statler Building ..... Hubbard 2-1728
MICHIGAN
Detroit 21, 10329 W. McNichols Rd. ..... University 4-4284
MINNESOTA
Minneapolis 3, 717 Merchandise Building ..... Federal 3-0714
MISSOURI
Kansas City, 300 Crawford Building ..... Harrison 1-7301
St. Louis 2, 434 Cotton Belt Building ..... Chestnut 1-7892
NEW JERSEY
Springfield, 420 Morris Ave. ..... Drexel 6-3810
NEW YORK
Buffalo 7, 1807 Elmwood Avenue ..... TR 3-3754
New York 19, 250 West 57th Street ..... Circle 5-4953
Schenectady, 639 State Street ..... Franklin 2-2908
Syracuse 2, 109 South Warren Street ..... Harrison 2-7700
NORTH CAROLINA
Charlotte, P.O. Box 3180 ..... Franklin 5-7658
OHIO
Akron ..... Enterprise 4146
Cincinnati 37, P.O. Box 2512 ..... Elmhurst 1-0328
Cleveland 2, 8905 Lake Avenue ..... Atlantic 1-6924
Columbus 15, 101 N. High Street ..... Capitol 1-6133
Dayton 32, 3898 Linden Ave. ..... Clearwater 6-1411
OKLAHOMA
Tulsa 3, 609 Mayo Building ..... Luther 4-2178
OREGON
Portland ..... Capitol 2-6529
PENNSYLVANIA
Harrisburg ..... Regent 7-5811
Philadelphia 7, Market St. National Bank Bldg. Locust 3-2386
Pittsburgh 5, 2250 Noblestown Road ..... Walnut 2-2100
TENNESSEE
Knoxville, P.O. Box 202 525-5992
TEXAS
Amarillo, 101 Taylor Street ..... Drake 3-0641
Dallas, 528 Interurban Building ..... Riverside 2-4052
Houston 27, 3617 West Alabama Street ..... Mohawk 7-6509
UTAH
Salt Lake City 11, 138 South Second East ..... Elgin 5-0276
WASHINGTON
Seattle 1, 101 Jones Building ..... Main 3-3361
WEST VIRGINIA
Charleston 27, P.O. Box 1841 ..... Dickens 6-6472
WISCONSIN
Milwaukee, 440 E. Silver Springs Dr. ..... Broadway 6-4393

BRANCH FACTORIES

CHICAGO AREA — 2040 No. Hawthorne Ave., Melrose Park, Ill.
LOS ANGELES 22, CAL. — 6800 E. Acco St.
HOUSTON 6, TEXAS — 3617 W. Alabama St.

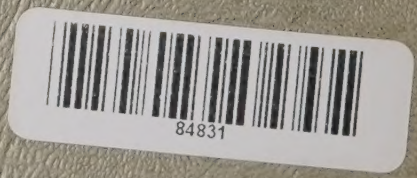
AFFILIATED COMPANIES

In Canada
THE BRISTOL COMPANY OF CANADA LIMITED
71-79 Duchess Street, Toronto 2, Ontario — Phone: Empire 3-3421
Branch Offices at Montreal, Quebec; Hamilton, Ontario; Calgary, Alberta; and Vancouver, B.C.

In Great Britain
ELLIOTT BROS., LTD.
Century Works
Lewisham
London, S.E. 13, England

BRISTOL'S

Printed in U.S.A.


84831